A HANDBOOK FOR DISSECTORS

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SANS TACHE

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PREFACE TO THE SECOND EDITION

This handbook was originally written for use in conjunction with "*A Method of Anatomy*," and it not only referred to that work by page and figure, but also left to it the account of the dissection of certain regions.

In this edition it has seemed desirable to let the handbook exist in its own right. Consequently, all reference to the larger descriptive work has been deleted and instructions for the dissection of every region have been included.

In fulfilment of this plan, some of the instructions here given have been taken from the larger work and incorporated with little or no change; to that extent the book remains a 'companion.'

Most students desire an inexpensive guide which they can use without too much concern for its ultimate condition, but which, containing enough information for the identification and exhibition of any structure met, relieves them of the necessity of consulting a more valuable work at an inopportune time. This by no means implies that the handbook can be used as a text-book. Indeed one of our chief aims has been to safeguard against such a possibility by avoiding, as far as possible, all descriptive matter and thereby encouraging the student in the use of his text-book the moment his dissection has progressed far enough to warrant it.

The account of the brain is not intended for advanced students, but aims to meet the needs of the beginner. In other words, it endeavours to give the medical student a scheme for the dissection of the brain which will enable him to acquire a knowledge of the specialized field of neuroanatomy sufficient to meet his needs.

We gladly express our thanks to Professor J. C. Watt for valuable advice in connection with the section on the head and neck, and to Dr. R. K. George who read and improved parts of the manuscript and is responsible for the index.

PREFACE TO THE FIRST EDITION

This handbook was written in the dissecting room three years ago and produced in mimeograph form for the guidance of those using *A Method of Anatomy*. Since then it has undergone many minor changes with a view to combining brevity with clarity, so that this first presentation in book form is virtually a third edition of its mimeographed prototype.

This is in no sense a textbook of Anatomy, but rather a guide to the orderly and consecutive display of the structures of the human body. Page and figure references to *A Method of Anatomy* are repeatedly given, and should be unfailingly consulted. Before dissection of a region begins, the dissector is urged to read the prescribed pages; when the dissection is completed, he must lay aside this handbook and, with the part before him, read the account of the region in the textbook verifying each statement by appealing to the part.

Some regions require (and receive) less ample directions than others. When, for example, the abdominal cavity is first opened the dissector is at once referred to his text-book, since he should do no dissection until he has mastered the positions of the organs and the intricacies of the peritoneum. Again, when the understanding of a region is best achieved by its examination concurrently with its dissection, then instructions for dissection are to be found in the text-book.

An effort has been made to discriminate between the more important structures for which **bold type** is used and the less important which appear in *italics*. The distinction is not always easy and no such discrimination can ever be entirely satisfactory to everybody.

A well-tried procedure for the dissection of the brain is included.

A word of warning to the beginner: Unless each step in the dissection is fully carried out, and in the order given, confusion will certainly result. This, of course, is true of any guide; but the point needs emphasizing, for our experience is that a great many difficulties the student encounters result from failure to meet this very fundamental obligation.

University of Toronto, J. C. B. G.
January, 1940. H. A. C.

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CHAPTER I

AN INTRODUCTION TO DISSECTION

When the student is assigned to a cadaver or "part" he assumes the responsibility for its proper care. He will find the subject has already been preserved, the arteries injected with a (red) coloring matter, the veins sometimes full of clotted blood, and sometimes empty. The limbs have been kept moist by adequate wrappings and the whole body suitably covered to prevent drying. It is the duty of the dissector to uncover only the part on which he is engaged, to inspect every part periodically and to renew and moisten wrappings as occasion demands. No part must ever be left exposed to the air needlessly and especial attention must be given to the face, hands, feet and external genitalia. Once a part is allowed to become dry and hard it can never be fully restored and its proper dissection becomes impossible.

For the protection of his own clothing the dissector should wear a long coat—preferably white—and, if at all possible, he should possess two, so that he may appear reasonably presentable at all times. He should keep his nails trimmed short and should at once seek the aid and advice of his demonstrator should he inadvertently suffer even a minor cut or stab wound. Injuries of this nature encountered in the dissecting room practically never give further trouble if allowed to bleed freely and then are attended to on the spot.

The dissector will need certain instruments. He may purchase a great number and of great variety, but he is wise if he procures merely the following:

1. **A pair of forceps** about 5″ long with handles transversely ridged to prevent slipping, ends blunt and rounded, and gripping surfaces corrugated.
2. **A seeker**, consisting of a rigid 5″ steel probe with blunt bent tip.
3. **A pair of scissors**, about 5″ long with the tip of one blade sharp and the other blunt.
4. **Two knives**: One for rough work with a squared end; the other with a smooth and rounded end. The blade of each knife should be about 1½″ long and narrow throughout. Its cutting edge will possess some convexity which, however, should be slight. The point should be well tapered. Knives must be kept sharp at all times, particularly the point and last half inch for they are the parts constantly used. Nobody can do good work with a blunt knife, so never seek the aid of a demonstrator unless you are prepared to offer him good instruments with which to work. Sharpen the knife daily; time spent in sharpening saves time in dissecting. Pointed needle-like seekers, as well as abruptly-hooked ones, should be banned from the dissecting room, as should those pointed little forceps that students seem to delight to acquire.

When the knife is very dull and considerable grinding is necessary, proceed as follows: Apply the heel of the blade to the right-hand end of the oil-stone with the edge making contact at an angle of 60° and the back of the blade raised free from the stone. The edge of the blade 'leads', and as it advances the guiding hand makes a sweeping movement describing a curve on the stone which is identical in shape with the curve of the blade of the knife itself. The stroke is not complete until the very tip of the blade has made contact with the stone. Make six strokes on one side of the knife then

six on the other side. Continue in this fashion until the desired result is attained.

To 'finish' or sharpen the edge, simply reverse the procedure by starting with the tip of the blade applied to the left-hand end of the stone and let the back of the blade 'lead'. Again reverse the side of the blade every six strokes (after the account by Dr. B. L. Guyatt).

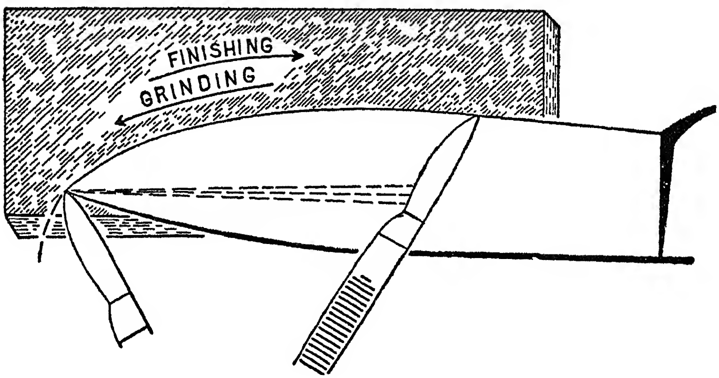

FIG. I. The excursion of the blade should describe the outline of the blade

Never dissect in a poor light; therefore arrange your table so that light falls—not on you—but on the part under investigation. Learn how to arrange the posture of the subject to the best advantage. Every dissecting room is equipped with wooden blocks; these are for your use in stabilizing parts and in maintaining correct posture. You will need sometimes to relax structures, sometimes to render them taut. Do not make things difficult for yourself.

The aim of dissection is to display the structures of the body so that their situations and relations may be rendered mani-

fest, i.e., their conformity to the statements about them in the text-book proved to the dissector's satisfaction. It is therefore of the essence of good dissection that each structure be displayed fully, clearly and cleanly. This takes time but it is time well spent. No mental picture can ever be obtained if blood vessels and nerves are seen only through a maze of fat and areolar tissue, if muscles are never cleaned to their bony attachments and if ligaments are left undefined as to their margins, direction of their fibres and attachments. Cleaning a structure, therefore, means much more than the mere recognition of its existence. Where arteries, veins and nerves accompany one another and have similar ramifications, it is usually highly desirable to sacrifice the veins for the sake of clarity. Nothing is lost by this procedure for, whilst veins are more numerous and rather more irregular than their companion arteries, a clean-cut display of the arteries is obtained and a knowledge of the general arrangement of the veins follows.

There are certain disadvantages inherent in the art of dissection. It is, for example, apparent that dissection must proceed from the surface to the depths. In this very obvious limitation lies the explanation of the somewhat discouraging fact, experienced by beginner and skilled dissector alike, that small and sometimes irritatingly insignificant structures are the first to be the subject of enquiry. The larger and often more important structures are only met as the dissection proceeds. It is therefore vital to the understanding of a region that it should be reviewed as a whole when its dissection is completed. What was at first perhaps a little obscure then becomes clear.

Again dissection can be, and often is, a tedious and time-consuming procedure. Let it be at once appreciated that it is a means to an end. The wise dissector exercises good

judgment in deciding what to spend his time about. To spend an hour tracing the terminal twigs of a cutaneous nerve right to the skin, when the general skin area supplied by the nerve is obvious, is spending an hour for little gain. To spend three minutes stroking with the point of a knife in order to define exactly the direction taken by the fibres of a small ligament, is to spend three minutes for great gain since a knowledge of the movements restrained or prevented by that ligament is the reward. Furthermore, and at the risk of being charged with emphasizing the obvious, it is pointed out that no one should ever dissect a structure whose identity has not been established. Follow the rule—first identify, then clean.

Lastly, it is apparent that dissection imposes on the dissector the limitation of proceeding region by region. This is in effect the way the surgeon operates. It is, however, highly desirable to know the human body also systematically, i.e., system by system, for that is the way the physician needs to know it. To counteract, therefore, the limitations of regional dissection the intelligent dissector will often find it desirable to review 'by systems'. This involves another point of view and entails rather wider reading than the region under examination seems to call for. If, for example, we have uncovered the median nerve in the axilla we now want to know a little more about it than we see before us. How is it formed? What is a mixed nerve? Where does it receive the impulses it conveys? What muscle groups is it destined for?—and half a dozen other queries. Therefore read more widely than at first you intended, for it will enable you to preserve continuity from region to region.

Before the dissection of any region is undertaken it is of the utmost service to the dissector to understand something of its general plan. It is for this reason that a few introductory remarks about each region precede the instructions for its

dissection. Whether this plan is used or another matters little so long as some general scheme of the *raison d'être* of every region be in the dissector's mind before he begins work. If one has some idea how a carburettor works he can proceed with some intelligence to take it apart.

Here we may remark that anatomy is a descriptive science as well as a process of dissection. It is altogether probable that the beginner has had little training in coping with a descriptive science. Indeed, he is often tongue-tied for want of experience in 'handling' such a subject. How shall he describe, say, the coracoid process? A few suggestions may not come amiss. First of all let him remember that anatomy is an ancient science. It has its own language and he must learn it. It's not a bit of use coining new words or terms when old and well-tried ones have the authority of age and use. Neither is it permissible to violate the conventions with which this time-honoured science is hedged about. Let him be on his guard. There have been several meetings of anatomists drawn from all parts of the world and the language now used—with certain permissible alternatives—is accepted by all and the beginner must fall in line or he will not be understood.

One of the most fundamental of these conventions concerns itself with the anatomical position. That is to say, anatomists have agreed in all their descriptive language to relate everything to a universally approved and accepted position of the body. It is that position in which the body stands erect with the feet together, arms by the side and the palms facing forwards. That the dissector is, on most occasions, working with the subject lying on its back makes not the slightest difference. When he says this or that structure is UNDER this or that muscle he is understood by all anato-

mists to mean it is nearer the feet. In all his speaking or writing, therefore, let the beginner beware lest he use his prepositions incorrectly. To avoid pitfalls every beginner should make it his business early to familiarize himself with the numerous directional terms in common use, and when he meets a term whose meaning is not at once apparent he should have recourse to his medical dictionary. Indeed a good medical dictionary is an indispensable text-book and a mine of useful information to beginner and expert alike. No one learns a new language save by acquiring a new vocabulary, and the vocabulary of anatomy is replete with useful descriptive words whose exact meaning it soon becomes a pleasure to know and appreciate.

If the student will take the trouble to open any good text-book of anatomy he will find the author does not write about his structures in any hap-hazard happy-go-lucky fashion. He uses a scheme. For instance in the description of any muscle it is altogether probable that the author had before him in writing his account some such scheme as this:

1. Form, Shape, Size, Position.
2. Origin and Insertion:
   (a) fleshy
   (b) tendinous
   (c) aponeurotic.
3. Nerve supply:
   (a) peripheral nerve
   (b) spinal segments.
4. Blood supply, Venous and Lymphatic drainage.
5. Immediate Relations:
   (a) anteriorly
   (b) posteriorly
   (c) medially

(d) laterally
(e) superiorly
(f) inferiorly.

6. Structure:
   (a) longitudinal
   (b) pennate
   (c) bipennate
   (d) circumpennate.
7. Development and Anomalies.

Now it may not suit his book to use *all* of these on every occasion but he knows how he is going to proceed with a descriptive account. Whatever type of structure he discusses he follows a well-tried procedure and it will amply repay the student to do the same. Therefore if for each type of structure a suitable scheme for its description is invariably adopted, the student will find that not only are his accounts presented in an orderly fashion but also his ability to remember and recall greatly enhanced. The following additional schemes are suggested for his consideration:

Bone:

1. Type (or classification) and Situation (where in body).
2. Form, Shape, Size and Appearance.
3. Parts—Shaft (Surfaces and Borders) Extremities, Articulations.
4. Muscles and Ligaments attached to each border and surface.
5. Contacts and Relations.
6. Structure and Anomalies.
7. Ossification and Epiphyses (relation to joints).

Joints:

1. Class and type. (e.g. Synovial joint of Hinge type.)
2. "Proximal" bone described.

3. "Distal" bone described.
4. Capsule: (a) fibrous; (b) synovial.
5. Bursae: (a) communicating; (b) non-communicating.
6. Ligaments: (a) capsular; (b) accessory.
7. Movements (naming muscles concerned).
8. Nerve and Blood supply.
9. Development and Anomalies.

Muscle: (see scheme on page 7).

Blood Vessel or Nerve:

1. Size, Source and Situation.
2. Course and Terminal branches.
3. Collateral branches, Anastomoses and Structures supplied.
4. Immediate relations and accompanying structures.
5. Variations and Anomalies.

There is nothing absolute about these schemes. The dissector may vary them and should develop others of his own. It is suggested that he develop one now, for the adequate descriptive discussion of, say, an organ. He will find his scheme will contain many headings found under one or other of those given. It is not with the object of enabling the student more readily to pass examinations that he is urged to do all this, though no doubt that will appear a sufficient reason: it is rather to develop the habit of orderly thinking for that after all is a habit without which no amount of even faithful work and attendance will lead to permanent knowledge.

No cadaver will conform in all the details of its anatomical construction to the pattern outlined in the pages of this manual. What are here described are the most usual patterns encountered. Minor and even major variants frequently occur; arteries may arise from other sources than

those indicated and may pursue different courses: muscles may have extra heads of origin or be wanting entirely; indeed, organs may vary from their accepted shape and (or) be found in other than 'normal' positions. When the student meets such variants he will sometimes find them explained in his text-book, sometimes he may need to consult either his demonstrator or a special work devoted to the subject. He should not spend much time over these variants but having obtained enough information about them to satisfy his scientific curiosity, he should see the more usual pattern as exhibited by his neighbour's subject and so familiarize himself with the accepted 'normal'.

CHAPTER II

THE UPPER LIMB

PECTORAL REGION AND AXILLA

The axilla or arm-pit is a fascia-filled space through which important structures course, and it comes into existence as a result of the need for a highly mobile upper limb. The side of the thorax is curved like the side of a barrel. The humerus or arm bone is relatively straight. Therefore, at its upper end, the humerus must be projected sufficiently far laterally as to allow the whole limb to swing clear of the chest. This is accomplished by a strut placed horizontally at the summit of the thorax and known as the clavicle or collar-bone, whose duty is to hold the scapula or shoulder blade—which carries the humerus at the shoulder joint—well away from the chest. The result is a pyramidal space whose truncated apex is bounded by the clavicle in front, by the upper border of the scapula behind, and by the first rib medially. The space possesses also four walls and a floor. The anterior wall, largely muscular, is suspended from the clavicle. The posterior wall consists of the muscles clothing the front of the scapula. The medial wall is the upper portion of the thorax with a large flat muscle applied to it; whilst out on the humerus anterior wall meets posterior wall save for a narrow strip on the humerus (lateral wall) along which the contents of the axilla make their escape. The skin of the arm-pit forms the floor. We are then to investigate:

1. The muscular anterior wall with its nerve and blood supply.

2. The muscular posterior wall with its nerve and blood supply.
3. The muscular medial wall with its nerve and blood supply.
4. The remaining contents of the axilla enter at the apex and pass to the free limb applied to the humerus at the narrow bony lateral wall.

Since the anterior wall of the axilla is sufficiently widespread as to clothe practically the whole front of the thorax we can also understand the necessity of investigating this part—the pectoral region—at the same time.

In order that he may be well orientated at all times the student should identify the following landmarks: Refer first to the skeleton where the bony landmarks are obvious. Check them on yourself or your partner and then identify them on the cadaver.

1. **Suprasternal notch**, a considerable depression at the root of the neck in the midline and marking the superior border of the manubrium sterni, the first segment of the sternum or breast-bone.
2. **Sternal angle** (of Louis), a transverse ridge about 2″ down from the suprasternal notch and marking the junction of the manubrium with the body of the sternum: it is at the level of the 2nd costal cartilage. This angle is very important as a surface landmark for it is from the 2nd rib that the remainder are identified.
3. **Xiphi-sternal junction**, at the 'pit of the stomach' and marking the level where the body of the sternum (bone) joins the xiphoid process (cartilage up to 45 years of age). Here the cartilage of the last 'true' rib (7th) reaches the side of the sternum.
4. The prominent **medial end of the clavicle**, bounding the suprasternal notch laterally.

5. The whole length of the **clavicle,** which is subcutaneous.
6. The **lateral end of the clavicle**, about 1″ medial to the 'point of the shoulder', and marking the acromio-clavicular joint.
7. The **acromion,** forming the point of the shoulder.
8. The tip of the **coracoid process**, 1″ below the clavicle under shelter of the Deltoid. It is felt by pressing laterally in the depression—the **infraclavicular fossa** or **delto-pectoral triangle**—seen below the clavicle near its outer end.

Now take the two bones of the shoulder girdle, correctly orient them with one another and, throughout the dissection of the region, keep them beside you for reference.

With the arm abducted to a right angle, grasp between fingers and thumb first the anterior and then the posterior axillary fold. The anterior fold is the rounded border of the **Pectoralis Major**; the posterior fold is the **Latissimus Dorsi** and **Teres Major**.

The following skin incisions are to be made and the outlined flaps reflected:

1. From the suprasternal notch lateralwards along the whole length of the clavicle and to a point one inch lateral to the tip of the acromion. (A superficial muscle and certain cutaneous nerves cross the clavicle. Therefore, cut with care and through skin only.) See fig. II, A to B.

2. Along the length of the midline of the sternum to the xiphi-sternal junction (fig. II, A to C).

3. From the xiphi-sternal junction horizontally lateralwards until you are stopped by the table (fig. II, C to D).

4. From the xiphi-sternal junction upwards and lateralwards towards the nipple (but avoiding it), thence following

the anterior axillary fold to a point one-third of the way down the front of the arm (fig. II, C to E).

In most subjects a variable amount of subcutaneous fat lies immediately deep to the skin and in that fat course cutaneous nerves and vessels—particularly veins. Therefore, in removing skin, all fat should be left behind. In those subjects nearly devoid of fat the dissector needs to exercise especial

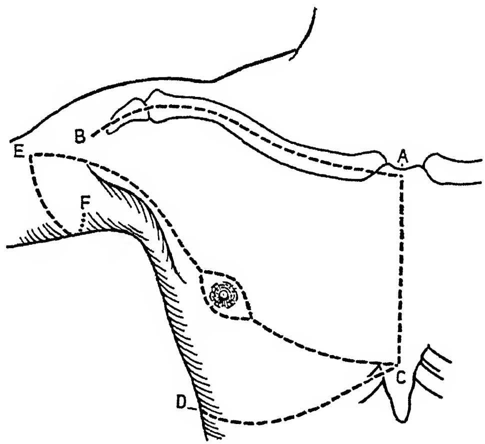

FIG. II

care lest he go too deep. If, in the course of his removal of skin, he sees muscle fibres shining through the filmy deep fascia that covers them, he is at once warned he is too deep. He will find the reflexion of skin a little tedious but if he remembers to put traction on the skin as it is being removed, to keep his sharp knife directed against it, and to leave the fat in place, he will work faster and encounter fewer difficulties.

THE ANTERIOR WALL OF THE AXILLA. The mammary gland lies in the superficial fascia, since it is a modified skin gland.

The rounded contour of the female breast is due to the superficial fat lying in compartments bounded by areolar septa—the *ligaments of Cooper*—that pass from the deep fascia to deeper parts of the skin. These collections of fat should be scooped out with the rounded handle of the knife. It will then be possible to trace some of the **lactiferous ducts** which converge, beneath the pigmented and fat-free **areola**, on the **nipple**. Or, it may be possible to recognize one of the ducts in the areola and to trace it peripherally, removing fat as you proceed. When a few of these lactiferous ducts have been traced and the structure of the breast thus revealed, read your text-book account of it.

The brownish-red fibers of the **Platysma**, no thicker than a sheet of paper, are met, often as scattered bundles, crossing the clavicle and descending as far down as the second rib. (Throw the muscle into action in your own neck and see how far it extends over the thorax.)

Deep to the superficial fascia lies the delicate, transparent, deep fascia that covers the Pectoralis Major. At the level of the 2nd rib make a horizontal incision down to this deep fascia but avoid injury to it. Turn up the Platysma. As the clavicle is approached find the **supraclavicular nerves** crossing it. They are deep to the Platysma, descend from the neck, and are to be found in the reflected flap. The lateral nerves being the larger should be sought first. Next make a vertical cut through the superficial fascia down the midclavicular line and a horizontal cut through it corresponding to the lower horizontal skin incision. Reflect the two flaps of superficial fascia, the one medialwards and the other lateralwards.

As the dissection proceeds laterally, the **anterior branches of the lateral cutaneous branches of the intercostal nerves** must be sought on the deep surface of the flap in front of the midaxillary line. They are segmental structures and emerge from intercostal spaces which can be located by palpating with the finger-tips. The nerves run forwards in the flap. Do not seek them any higher than the third intercostal space, since above that level they are in part distributed to the limb. Behind the midaxillary line, somewhat smaller **posterior branches of the lateral cutaneous branches** are encountered. They run backwards. Similarly, as the superficial fascia is reflected towards the sternum, very small branches are met in the intercostal spaces close beside the sternal margin. These are the **anterior cutaneous nerves** and with them, in a well-injected subject, will be found **perforating cutaneous** twigs of the internal mammary artery. Read now an account of a typical spinal nerve.

Identify once more the **infraclavicular fossa** or **delto-pectoral triangle.** It leads, at its apex, to the groove between the **Pectoralis Major** and the **Deltoid.** In this groove, deep to the filmy deep fascia, find the **cephalic vein** which may be full and obvious or empty and inconspicuous. Along its course are two or three very small lymph nodes. Lymph nodes are pale, brownish, ovoid bodies easily mistaken for little fat masses. They may be no larger than a pin-head or they may exceed an inch in length. They are found along the courses of the veins. Follow the cephalic vein upwards to the triangle and downwards to the limits of the skin incision.

Clean the whole anterior surface of the **Pectoralis Major.** Find and define the division between its sternal and clavicular heads and separate them throughout. Notice that the clavicular head overlaps the main mass, and begins at the

sterno-clavicular joint. Trace the tendon of the muscle to its bony insertion and clean it. Observe that the anterior lamina of the tendon belongs to the clavicular head; that the posterior lamina is folded on itself and belongs to the sternal head; that from the posterior lamina a thin expansion runs upwards to the shoulder joint.

Pass a finger behind the clavicular head and feel its nerve of supply—the **lateral pectoral nerve**—entering the deep aspect of the muscle. Cut through the clavicular head a finger's breadth below the clavicle and reflect it towards the arm. Its nerve will either have to be severed as the reflection proceeds, or better, a button of muscle may be cut out with the nerve and retained for subsequent identification. Rotate the limb medially in order to render the Pectoralis Major lax and gently insinuate the fingers behind the **sternal head** of the muscle, first from above and then from below; then raise it and feel and see the vessels and nerves entering it. The underlying sheet behind your fingers is the **clavipectoral fascia.** Using your fingers as a guide, make two vertical cuts through the raised muscle, one lateral to the line of entrance of the nerves and vessels, and the other medial to this line; and so leave in place a section of muscle, with vessels and nerves attached.

After the Pectoralis Major has been cleaned and studied, reflect it in order to expose the second layer of the anterior wall of the axilla. This is the **clavipectoral fascia.** It extends from the clavicle above to the axillary fascia below. It embraces two muscles, the **Subclavius** and the **Pectoralis Minor,** forming a sheath for each. The triangular part between the two muscles is called the **costo-coracoid membrane.** It extends from the first and second costal cartilages laterally to the coracoid process. Here its upper border may be so well developed as to warrant the name *costo-coracoid*

ligament. Now trace the **cephalic vein** across the front of the tendon of the Pectoralis Minor to where it pierces the membrane. With it pierce the **lateral pectoral nerve** and the **acromio-thoracic artery** and **vein.** The cephalic vein receives the acromio-thoracic vein just before piercing the costo-coracoid membrane to end in the axillary vein. Verify these facts as you clean the structures and remove the acromio-thoracic vein and its tributaries so as better to observe the distribution of the acromio-thoracic artery whose branches (*acromial*, *deltoid* and *pectoral*) radiate from its short stem like the spokes of a wheel from a hub.

Define the upper or medial border of the **Pectoralis Minor;** remove the fascia from its anterior surface and trace the muscle to its tendinous insertion on the coracoid process. Clean its lower or lateral border and find, piercing the muscle, the **medial pectoral nerve.** Read an account of the Pectoralis Minor.

With the arm abducted feel in the second intercostal space deep to the Pectoralis Minor. Here a taut nerve, the **intercosto-brachial,** is at once apparent. Feel it stretching as a string across the base of the axilla and trace it through the fat freeing it as you proceed. Nothing of importance crosses it as a rule, so you may dissect freely. It pierces the deep fascia as it enters the arm, having crossed the tendon of the Latissimus Dorsi. Leave it cleaned to this point. Note: In some subjects the 3rd nerve may also cross the axilla as an "intercosto-brachial".

THE POSTERIOR WALL OF THE AXILLA. With the arm still abducted to a right angle place a block under the elbow in order to raise it from the table, thereby relaxing the structures within the axilla and rendering taut the **Latissimus Dorsi.** If this procedure does not achieve the desired result,

ask your partner to hold the limb with the elbow raised, while you proceed with the dissection. Feel the lower border of the Latissimus Dorsi, already identified as the posterior axillary fold, incise the fat along it and clean the border right to the chest wall. At once identify the **nerve to the Latissimus Dorsi** entering the axillary surface of the muscle. It does not reach the border but is found a finger's breadth away, near its midpoint. It is accompanied by branches of the **subscapular artery** and **vein**, which are the vessels of the posterior wall. Identify these vessels but leave them undisturbed until the other nerves of the wall have been found. Do not cut the nerve but trace and clean it upwards until it disappears into tubular **axillary sheath** which surrounds the great vessels and nerves. A finger's breadth lateral to the nerve to the Latissimus Dorsi, near its upper end and parallel to it, a slightly smaller nerve, the **nerve to the Teres Major,** is found. The Teres Major lies along the axillary border of the scapula. Its tendon is closely associated with that of the Latissimus Dorsi. Its nerve passes behind the subscapular artery (the nerve to the Latissimus Dorsi passes in front) and it gives also a branch to the **Subscapularis,** the muscle clothing the front of the scapula. Trace the nerve downwards to its muscles. Similarly, about the same distance medial to the nerve to the Latissimus Dorsi and also parallel to it, lies the **nerve to the Subscapularis.** It is high up in the axilla and runs but a short course before it sinks into the upper (medial) part of the Subscapularis. If the great vessels and nerves in their tubular sheath are retracted, this nerve is more readily followed.

Now clean the **subscapular artery** and its branches removing entirely not only the companion vein and its tributaries but also the lymph nodes of the posterior wall found along the course of the vein. This will greatly clarify the picture.

Sweep the finger up and down in the angular interval between the medial and posterior walls, in order to open the space more widely. Remove now all the areolar and fatty tissue from the three muscles of the posterior wall. This can safely and speedily be done because their nerves have been found. Pass a loop of string or tape around the axillary sheath, and hold it forwards and lateralwards in order to allow you to clean the tendon of the **Latissimus Dorsi** to its insertion. A common branch—the **posterior cutaneous nerve of the arm** (sensory) and the **nerve to the long head of the Triceps** (motor)—is usually seen leaving the sheath in front of the tendon. This branch must be left uninjured. The tendon of the Latissimus Dorsi is pearly, at least an inch wide, and ribbon-like. Separate it from the equally wide but shorter tendon of the **Teres Major** which adheres to its posterior surface and may be fused with it inferiorly. The Teres Major tendon extends a little further down the humerus and a bursa lies between the two tendons at their insertions, so where the bursa occurs separation is most readily effected. Study the muscles.

Open the space which exists between the **Latissimus Dorsi** and **Teres Major** on the one hand and the **Subscapularis** which lies above them on the other; then identify and clean the **long head of the Triceps,** which crosses the space in its depths. Insert the finger into the space, lateral to the Triceps tendon, and feel the neck of the humerus laterally and the capsule of the shoulder joint above. This is the **quadrangular space.** Find in it the **circumflex nerve** and its companion, the **posterior humeral circumflex artery.** Clean them.

THE MEDIAL WALL OF THE AXILLA. One muscle here clothes the ribs and intercostal muscles. It is the **Serratus**

Anterior. Its nerve is found clinging to it along the midaxillary line. Clean the nerve from below upwards but avoid injury to the twigs running from it into the muscle. You cannot follow it now to its origin, for it arises from the *roots* of the brachial plexus.

Clean the vessel of this wall, the **lateral thoracic artery,** found close to the lower border of the Pectoralis Minor. It has a companion vein which, like the vein of the posterior wall, is accompanied by a chain of lymph nodes. Vein and nodes should be removed. An additional vessel, the *superior thoracic*, may be found higher up, or the wall may be supplied by a vessel arising from the subscapular. The pattern of origin of vessels is not absolute.

THE CONTENTS OF THE AXILLA. The muscles arising from the tip of the coracoid process pass through the axilla in contact with the bony lateral wall, i.e., the **bicipital groove.** They are the **Coraco-brachialis** and the **short head of the Biceps.** Identify them and notice that they lie lateral to the remaining contents of the axilla which are enveloped in the **axillary sheath.** Remove the remains of the costo-coracoid membrane and free the sheath from behind the sheath of the **Subclavius** (the little muscle immediately below the clavicle) to which it adheres. Open into the axillary sheath, if not already done, and pass the handle of the seeker along it and within it, in order to open it widely and to demonstrate its tubular nature. Observe the relationships of the structures immediately behind the tendon of the Pectoralis Minor. Here the axillary artery is surrounded by the three **cords** of the **brachial plexus**; the axillary vein, lying medial to the artery, is in front of the medial cord. Cut the tendon of the Pectoralis Minor and reflect the muscle.

There is, of course, more than one way of identifying the

parts of the brachial plexus. Perhaps as good a way as any is first to find the **musculo-cutaneous nerve.** Two features at once identify it: (1) it is the most lateral nerve of the plexus; (2) it enters the substance of the Coraco-brachialis. Render it taut and obvious by pushing the contents of the axillary sheath medially. Before it enters the Coraco-brachialis, the musculo-cutaneous nerve gives off a delicate branch to that muscle; this branch arises from the parent stem less than 1″ below the coracoid process.

Having secured the musculo-cutaneous nerve trace it proximally to the **lateral cord,** whose other terminal branch is the **lateral head of the median nerve.** Follow the lateral head distally and identify the **median nerve.** Trace the **medial head of the median nerve** proximally until it conducts you to the **medial cord.** Identify the other three branches of the medial cord. The largest is the **ulnar nerve;** the next in size is the **medial cutaneous nerve of the forearm;** the smallest, the **medial cutaneous nerve of the arm,** often has a loop of communication with the intercosto-brachial nerve already identified.

The **posterior cord** is seen better after the axillary vessels have been cleaned. Proceed now to clean these vessels, removing, as they are met, the **central axillary lymph nodes** along their course. If, as is sometimes the case, the axillary vein is double remove one and preserve the other, and remove all the tributaries of the vein entirely. Do not desist until the **axillary artery** is cleaned throughout and the sites of origin of all its branches are well defined. These have all been identified already with the exception of the small **anterior humeral circumflex artery** which almost invariably arises very close to the origin of the much larger posterior humeral circumflex. Find it and note its course. Review the axillary artery and its branches.

Behind the axillary artery the **posterior cord** can now be investigated. It is the largest cord and one of its two terminal branches—the **circumflex nerve**—has already been seen in the quadrangular space. View the origin and course of the circumflex nerve now. The large **radial nerve** is the other terminal branch. You now have an opportunity to see more fully the sites of origin of the nerves supplying the muscles of the posterior wall. Review the whole axilla.

THE CUTANEOUS NERVES AND VEINS

The limbs make their appearance in the developing embryo as buds growing outwards from the side body wall. As these buds elongate they are invaded by the segmental nerves in the vicinity. If one holds his upper limb out at right angles from the side with the palm facing forwards and the thumb up, thus simulating a developing bud, it is easy to appreciate that, in its invasion in regular order by the segmental nerves represented by the brachial plexus, C.5 and C.6 will concern themselves with the upper (pre-axial) border of the limb, C.8 and T.1 with the lower (post-axial) border, whilst C.7—the central nerve of the limb bud—will burrow down the middle. No matter by what peripheral nerve various portions of the skin area are reached this fundamental pattern of segmental supply will be maintained. Thus a nerve supplying the skin on the radial side of the forearm front and back will contain segments C.5 and 6; on the ulnar side it will contain segments C.8 and (or) T.1; C.7 is liable to appear at the surface in the mid-axis of the limb and may reinforce either side. It is the duty of the dissector to know not only the peripheral nerves supplying a skin area, but also the segments of the spinal cord from which each nerve arises. This he can never fail to know if he understands the fundamental segmental pattern just outlined.

In both upper and lower limbs are to be found important cutaneous veins unaccompanied by corresponding arteries. In the upper limb these begin in a venous arch on the back of the hand. From the medial side of the arch a prominent vein —the **basilic vein**—reaches the front of the limb just below the elbow where it is joined by numerous tributaries and, plunging deeply at about the middle of the upper arm, becomes the principal vein of the limb—the **brachial vein.** From the lateral side of the arch there proceeds the **cephalic vein** which gains the front of the limb just above the wrist and, pursuing its course up the lateral side of the limb, remains superficial until it approaches the shoulder region where it too turns deep to enter the **axillary vein.** At the elbow a variable pattern of union exists between the two veins.

Remove the skin entirely from the upper limb down to the level of the lowest skin-crease at the front of the wrist. Proceed as follows: Remove entirely the upper skin flap of the thorax already reflected, by an incision along its line of attachment (figs. II and III, B to E). Starting at E (fig. II) incise the skin circularly right round the root of the limb (figs. II and III, E to F to B). At the level of the palpable styloid process of the radius make another circular incision right round the limb (fig. III, G to H). Join the two circular incisions by a vertical one down the length of the anterior aspect of the limb (fig. III, I to K). Reflect the skin medially and laterally until it is all removed. Notice that the skin is thin and delicate on the medial side, thicker and tougher laterally. On either side of the Biceps are the medial and lateral bicipital furrows in which nerves and veins are to be found.

Investigate the cutaneous nerves in the following order:

1. Follow to its termination the **posterior cutaneous nerve of the arm** already found.
2. Trace the **intercosto-brachial nerve** throughout.
3. The *medial cutaneous nerve of the arm* is slender and should be followed from the medial cord to its termination.

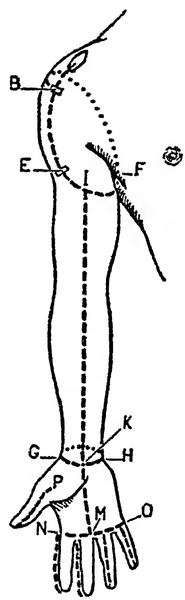

Fig. III

4. Identify the posterior border of the Deltoid. Notice it corresponds to a line joining the root of the spine of the scapula to the deltoid tuberosity halfway down the lateral aspect of the humerus. If an incision be made parallel to and behind this border, and the border pulled forwards, the **upper lateral cutaneous nerve of the arm**

will be found turning forwards around the muscle below its mid-length, and so becoming cutaneous.

5. From the lateral epicondyle to a point halfway up the arm is the line of the lateral intermuscular septum which separates the Triceps behind from the Brachialis, Brachio-radialis and Extensor Carpi Radialis Longus in front. After reference to the skeleton, identify this line by palpation and make a vertical incision through the superficial fascia just behind it. Along this line a small twig, the *lower lateral cutaneous nerve of the arm*, and a large branch, the **posterior cutaneous nerve of the forearm,** are to be sought. The twig is above and is too small to delay you long; the branch is lower down and cannot be missed. Both course downwards and slightly forwards and are accompanied by a branch of the profunda artery which, in a well injected subject, will serve as a guide to them.
6. The **medial cutaneous nerve of the forearm** pierces the deep fascia in the medial bicipital furrow near the mid-length of the arm and with the basilic vein.
7. The **lateral cutaneous nerve of the forearm** appears 1″ or 2″ above the elbow, from under cover of the lateral border of the Biceps. All these nerves should be traced distally as far as possible. The small *palmar cutaneous nerves* are difficult to find; read an account of them.

Trace the **cephalic vein** distally to the wrist level. Find the **basilic vein** piercing the deep fascia with the medial cutaneous nerve of the forearm and trace it distally. Observe the pattern these two veins make at the front of the elbow and compare this with that observed on your own arm. Notice the **deep vein** joining the superficial ones just below the elbow. Study the cutaneous nerves and veins of the upper limb.

THE SCAPULAR AND DELTOID REGIONS

The highly mobile upper limb is securely anchored to the axial skeleton by wide-spread muscles. This is particularly true posteriorly where this anchorage is so extensive that it reaches from the head above to the pelvic girdle below, completely covering the whole back. The native or intrinsic muscles of the back, supplied by the segmentally disposed posterior nerve rami, have become separated from the skin (also supplied by posterior rami) by these invading muscles which, arranged in two layers, retain their nerve supplies from anterior rami.

It is therefore the duty of the dissector first to identify these posterior rami after they have pierced the wide-spread musculature (which they ignore) and to observe their cutaneous distribution. Next he must investigate the first layer of these wide-spread muscles and their nerve and vascular supplies. More deeply placed he will find the smaller muscles of the second layer, also belonging to the upper limb girdle, which, together with those intimately surrounding the shoulder joint, constitute a numerous group for his attention.

It will be appreciated that the vessels reach these posteriorly placed muscles by crossing the root of the neck having come from the anteriorly situated subclavian artery. Thus one vessel—the **transverse cervical artery**—gains the vertebral border of the scapula at the superior angle by crossing the root of the neck from front to back. The other—the **suprascapular artery**—runs lateralwards towards the lateral angle of the scapula. Each is joined by a nerve from the brachial plexus as that plexus traverses the neck. One nerve however—the **accessory nerve**—pursues a somewhat peculiar course.

At all times the dissector must keep himself well oriented, remembering the position the subject is in. To ensure this he should work with a clavicle and a scapula, correctly articulated, beside him.

Turn the cadaver face downwards, place a block lengthwise beneath the chest so that the scapulae fall laterally and the head falls forwards.

After reference to the skeleton identify the following landmarks:

1. The **seventh cervical spine.** It is the first prominent vertebral spine encountered as the fingers run down the midline of the neck.
2. The **spine of the scapula.** It should be traced medially from the acromion at the point of the shoulder until it fades away at the vertebral border.
3. The **vertebral border** and **inferior angle of the scapula.**
4. The **crest of the ilium,** terminating posteriorly in the **posterior superior iliac spine** where a dimple is often present in the skin.

Make a vertical skin incision in the midline from the prominent seventh cervical spine to the level of the palpable posterior superior iliac spines (fig. IV, R to S). At the upper extremity of this vertical incision make one horizontally lateralwards to a point one inch beyond the tip of the acromion (fig. IV, R to B). At the lower extremity of the vertical incision make an incision which at first runs parallel to, and just above, the palpable iliac crest; as the midlateral line is approached the incision must leave the crest and run horizontally till stopped by the table (fig. IV, S to T). Another horizontal incision at about the level of the inferior angle of the scapula will aid in the reflexion of the large flap outlined (fig. IV, U to V). Reflect the skin well laterally.

Notice that over the back it is very thick and tough. If the cadaver has lain on the back, the subcutaneous tissues are probably infiltrated with the preservative fluid.

Make a horizontal cut through the superficial fascia at the level of the inferior angle of the scapula. This will enable

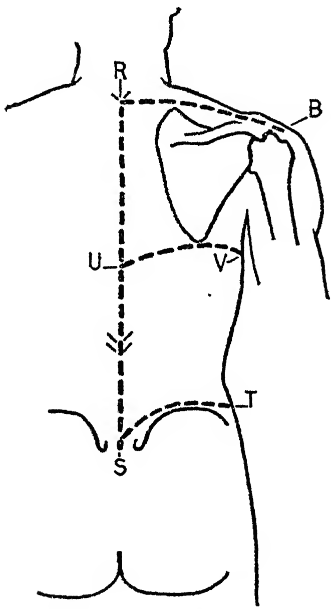

FIG. IV

you to identify the plane of the film-like deep fascia covering the fleshy muscle fibers. Make two other cuts, one corresponding to the upper horizontal, and the other to the vertical, skin incision, down to the determined plane of the deep fascia. With the rounded handle of the scalpel proceed to scrape off or strip the superficial fascia from the deep

fascia, beginning at the midline and working laterally. Very close to the vertebral spines look for representatives of the cutaneous nerves. They are **branches of the posterior nerve rami,** and naturally are spaced a vertebra apart down the back; in the lower half of the region they are found a little further away from the midline. The posterior branches of the lateral cutaneous nerves have already been identified in the axilla. A representative of them should be traced further now.

Note: When the subject is fat, cutaneous nerves are liable to be found close to the deep fascia and not floating, so to speak, free on the surface of the fat as you might expect.

In seeking the lumbar representatives of the posterior nerve rami, make a 4″ vertical incision through the superficial fascia two fingers' breadth from the midline, extending upwards from the level of the lower horizontal skin incision. As the fascia is eased laterally, the cutaneous branches of the **posterior rami of the upper lumbar nerves** will be found piercing the deep fascia in series and descending vertically over the iliac crest.

Remove the remains of the superficial fascia from the whole region. By the use of blocks and posture render tense the fibres of the muscles that are now to be cleaned. In the vicinity of the iliac crest cotton-waste may be used to soak up the fluid that oozes from the depths.

Follow and clean the vertically-running lateral border of the Latissimus Dorsi from the point where it was cleaned in the axilla to its origin from the iliac crest.

Notice above the middle of the iliac crest the narrow triangular interval which exists between the free borders of the Latissimus Dorsi and the **External Oblique,** a muscle of the abdominal wall. This, the **lumbar triangle,** is better left undisturbed until the abdominal wall is dissected. Clean the

thin and ill-defined horizontal upper border of the **Latissimus Dorsi** extending laterally from the 6th or 7th thoracic spine and note that it crosses the inferior angle of the scapula and is crossed by the **Trapezius.** Clean the surface of the Latissimus Dorsi and verify the following additional statements about its origin:

(a) the fibres that arise from the outer surfaces of the lower 3 or 4 ribs interdigitate with fibres of the External Oblique.

(b) the muscle gains attachment to the lumbar spines by arising from the surface of the **lumbar aponeurosis** which covers in the native musculature.

(c) a few fibres arising from the inferior angle of the scapula commonly join the muscle as it crosses that angle.

The upper half of the Trapezius belongs to the dissectors of the neck, therefore, clean the lower half only and, when its lower border is defined, observe that it runs obliquely upwards and lateralwards from the spine of the 12th thoracic vertebra to the tubercle on the crest of the spine of the scapula. Investigate the **triangle of auscultation.** It is the triangle bounded medially by the lower border of the Trapezius; inferiorly by the upper horizontal border of the Latissimus Dorsi; laterally by the vertebral border of the scapula. The triangle is large and obvious when the scapula is well protracted, small and insignificant when the scapula is retracted. In the triangle define the exposed portion of the medial (lower) border of the **Rhomboideus Major** as it approaches the inferior angle of the scapula and, by cleaning the fascia in the triangle, expose the rib and two intercostal spaces forming the floor.

At the level of the upper horizontal skin-cut, divide the Trapezius into two parts by an incision which runs parallel to the horizontally-running fibres. You will be guided as to depth by remembering that the division must reach an

inevitable layer of loose areolar tissue whose presence deep to the Trapezius you might postulate. Carry the incision from the midline right out to the acromion. (Remember by the use of blocks to have the head and neck well flexed and the scapulae well protracted.) In the loose areolar tissue the **accessory nerve** crossing the superior angle of the scapula is at once identified. Accompanying it is the **ascending branch of the transverse cervical artery.** Clean nerve and artery.

Pass the fingers in front of the lower half of the Trapezius (i.e., deep surface), free it and then divide it vertically about its middle, being careful of the underlying muscles. These are the **Levator Scapulae** and the **Rhomboidei Minor et Major** inserted, in that order from above downwards, on the vertebral border of the scapula. As the Trapezius is turned to its origin the stems of any cutaneous nerves not previously identified will readily be seen entering the deep surface of the muscle near the spines. Clean the muscles now revealed. Define first the anterior border of the Levator Scapulae. (Your fingers are useful and sensitive dissecting instruments.) Separate the Levator from the Rhomboideus Minor and, in the interval close to the vertebral border of the scapula, find the **nerve to the Rhomboids** and the companion **descending branch of the transverse cervical artery.** You can best do this by rendering the parts tense and then feeling for the delicate nerve with your finger. The main stem of the artery will be found at the anterior border of the Levator Scapulae. The origin of the transverse cervical artery from the thyrocervical trunk cannot be seen until, or unless, the posterior triangle of the neck has been dissected. Read an account of it.

Run the finger along the sharp upper border of the scapula from the superior angle to the coracoid process. As the

coracoid process is approached locate the sharp *suprascapular ligament* bridging the suprascapular notch. With the seeker find the **suprascapular nerve** crossing below the ligament and the **suprascapular artery** crossing above it. Clean the ligament, artery and nerve as far as possible. Arising from the ligament and from the adjacent part of the bone will be seen the narrow fleshy ribbon-like **inferior belly of the Omohyoid** muscle.

Define the medial (or lower) border of the Rhomboideus Major and then, by thrusting the inferior angle of the scapula backwards, free the muscle from the underlying ones which belong to the axial skeleton. Lastly, free the Latissimus Dorsi from the underlying muscles and cut it across immediately lateral to the inferior angle of the scapula. This will lessen the chances of injuring the underlying Serratus Anterior. Using the fingers, turn the medial part of the Latissimus towards its origin and then define, clean and examine the **Serratus Anterior.** It clothes the chest wall and also is inserted into the vertebral border of the scapula. Observe that the lower borders of the Rhomboideus Major and Serratus Anterior are in line with one another. Cut the Rhomboids in order to secure a good view of this important muscle.

Study the upper end of the humerus.

Clean the **Deltoid** and verify its attachments. It is the muscle whose origin is co-extensive with the insertion of the Trapezius save for the subcutaneous surfaces of clavicle and scapula palpable between them. Its fibrous insertion, half way down the humerus, gives partial origin to, and is embraced by, the origin of the **Brachialis**—the muscle clothing the anterior aspect of the lower half of the humerus.

Abduct the humerus in order to render the Deltoid slack, pass a forefinger deep to each of its two borders and free the

muscle from the humerus. The "posterior" finger will feel the circumflex nerve entering the deep surface 2″ below the acromial angle. Sever the muscle $1\frac{1}{2}''$ below and parallel to its origin. Trace the nerve as far as the anterior border. Turn the two parts of the muscle up and down. Observe, and appreciate the significance of, the septa seen on the deep surface of the muscle.

Deep to the Deltoid and to the acromion lies the **subacromial bursa;** open it by a longitudinal cut and explore its extent with the handle of the probe. To accomplish this, pull the humerus downwards and the acromion upwards. The bursa sometimes communicates with the shoulder joint as a consequence of attrition of the Supraspinatus tendon which lies below the Deltoid.

The tendons of the **Supraspinatus, Infraspinatus** and **Teres Minor** are now revealed. They are so intimately blended with the capsule of the shoulder joint as to be almost inseparable from it. Leave them in place but observe their ultimate insertions in the three facets on the greater tuberosity of the humerus. They will be more fully examined later.

Follow the **circumflex nerve** and the **posterior humeral circumflex artery** back to the **quadrangular space;** open the space and look for the branch of the circumflex nerve to the Teres Minor and, still deeper, its twig to the capsule of the shoulder joint. This twig will probably not be found. The artery gives off an important anastomotic branch which descends on the humerus medial to the lateral head of Triceps to join the profunda brachii artery.

Clean the **long** and **lateral heads** of the **Triceps**—the muscle occupying the back of the arm. The long head, arising from the infraglenoid tubercle, runs between the two Teres muscles; the lateral head arises from a line running downwards from the insertion of the Teres Minor to the insertion of the

Deltoid. Clean the Teres Major, whose insertion has already been observed, and separate the Latissimus Dorsi from it, noting the manner in which the fibers of both muscles run spirally to their insertions.

Separated from the quadrangular space by the long head of the Triceps is the *triangular space*; open it and follow the **circumflex scapular artery** through it to the dorsum of the scapula. Separate the **Teres Minor** from the **Infraspinatus.** Rotate the humerus laterally in order to slacken the Infraspinatus and, with the handle of the knife, separate the muscle from the lateral part of the spine and from the neck of the scapula. Insinuate a finger between the Infraspinatus and the scapula and feel its nerve. Sever the muscle $1\frac{1}{2}''$ medial to its humeral insertion and reflect it. You will then see the infraspinous branch of the suprascapular nerve, with its companion artery, coming through the spino-glenoid notch to enter the muscle. The artery may be followed to its anastomosis with the circumflex scapular artery. It is wise *not* to sever at this time either the Supraspinatus or the Teres Minor.

Turn the subject on its back.

THE UPPER ARM AND THE FRONT OF THE ELBOW

The situations of the important structures as they enter the limb from the axilla have been observed; if now their situations at the elbow region are appreciated it becomes a simple matter to understand their courses in the arm.

The dissector, therefore, first investigates the region of the front of the elbow, where he pays particular attention to the positions of the brachial artery and the median and radial nerves. In doing this he further observes that certain muscles of the forearm reach above the elbow. Of these the

flexor group arises from the medial epicondyle and its supra-condylar ridge, whilst the extensor group arises from the lateral epicondyle and its supra-condylar ridge. In the intervening region between flexors and extensors the chief muscles of the arm pass to their insertions on radius and ulna.

Remove the superficial fascia for 2″ above and below the elbow. Identify and clean the exposed part of the **Biceps Brachii.** Do not follow its tendon yet, but define its insertion into the deep fascia on the medial side of the front of the forearm, called the **bicipital aponeurosis.** This bridges and so protects the **median nerve** and the **brachial artery.** Cut across the aponeurosis; note the relative positions of tendon, artery and nerve. The branches of the median nerve pass medially, so keep to its lateral side. Clean these branches and, by retracting the flexor muscles with the elbow bent, follow the nerve to where it passes deeply. Follow the lateral side of the Biceps and raise the tendon from the underlying fleshy **Brachialis.** Identify the **Brachio-radialis;** it is the muscle arising from the upper two-thirds of the lateral supra-condylar ridge of the humerus. Below the level of the elbow joint find the interval between the **Brachio-radialis** and the **Biceps tendon** and follow this up, noting that the Brachio-radialis overlaps the Brachialis. In the depths of this interval find the **radial nerve.** Its branches pass laterally, so keep to its medial side.

Remove the remains of the deep fascia from the front of the arm and in the process establish the continuity of the **basilic vein** with the axillary vein. Trace the **medial cutaneous nerve of the forearm** proximally to its origin from the medial cord.

Trace the **musculo-cutaneous nerve.** It runs through the Coraco-brachialis and then between the Biceps and the

Brachialis. Thereafter, it continues as the **lateral cutaneous nerve of the forearm** (already identified). Find the motor branches to these three muscles.

Trace the **median nerve** from axilla to cubital fossa (the region at the bend of the elbow), and note any communication it receives from the musculo-cutaneous nerve. The median nerve is formed on the lateral side of the axillary artery; at the elbow joint it was found on the medial side of the brachial artery. It crosses in front of the artery at the mid-length of the arm.

Pick up the **ulnar nerve** where it arises from the medial cord. Here it lies behind the axillary vein. Follow the nerve until it disappears behind the **medial intermuscular septum.** This septum, attached to the medial supra-condylar ridge, lies in front of the medial head of the Triceps above the elbow. It will be met again, so do not destroy it. Accompanying the ulnar nerve behind the septum are two slender structures, (a) the **ulnar collateral nerve,** a branch of the radial which ends in the medial head of the Triceps and, (b) the very slender **ulnar collateral artery.** Make a short in cision vertically through the deep fascia in the interval between the medial epicondyle and the olecranon, and here pick up the ulnar nerve again. Establish its continuity behind the septum but do not follow it any further distally at pressent.

Clean the **brachial artery** and its collateral branches:

(1) *muscular*—these are many.

(2) **profunda**—the largest, and runs with the radial nerve to the posterior compartment of the arm; so do not follow it at present.

(3) *nutrient*—enters the humerus about the insertion of the Coraco-brachialis.

(4) **ulnar collateral**—already seen.

(5) **supratrochlear**—1″ above the elbow, crosses behind the median nerve.

Separate the **Coraco-brachialis** from the **short head of the Biceps,** being careful of the musculo-cutaneous nerve. Follow both muscles to their origin from the tip of the coracoid process, and the Coraco-brachialis to its insertion. The origin of the **long head of the Biceps** cannot be investigated until the shoulder joint is dissected.

Flex and supinate the elbow in order to relax the tendon of the Biceps, then follow it to its insertion. As you clean the lateral side of its tendon, observe and open the bursa between it and the anterior part of the radial tuberosity Lift the Biceps from the underlying Brachialis and, in the broad fold attaching the two muscles as a "meso-muscle," see the vessels and nerves passing to the Biceps. The wholly fleshy origin of the **Brachialis** should now be defined. Notice the fleshy slip in the spiral groove behind the Deltoid insertion. Laterally, separate the Brachialis on the one hand from the Brachio-radialis and **Extensor Carpi Radialis Longus** on the other. This last muscle arises immediately below the origin of the Brachio-radialis. You have already observed that the Brachio-radialis overlaps the Brachialis. Now is a good time to refresh your mind as to the facts of the **intermuscular septa.**

Remove the deep fascia from the back of the arm. Then pick up the **radial nerve** in the axilla and observe once more: (1) that it lies behind the brachial artery and enters the spiral groove 1″ below the axilla; (2) that before entering the groove it gives off, (a) a stem common to the **posterior cutaneous nerve of the arm** and the **nerve to the long head of the Triceps,** (b) the **ulnar collateral nerve** (so called because it follows the ulnar nerve). These nerves are in danger and should be preserved.

Trace the **radial nerve** in the spiral groove—with its com-

panion, the **profunda artery**—to the lateral side of the arm where it has already been identified. Clean the **Triceps.** The long and lateral heads have already been dealt with. Observe that these two heads lie side by side and that the medial head is deep to both. The medial head, which is entirely fleshy, should be followed up to just below the insertion of the Teres Major. Note the radial nerve lying on this pointed head. With the elbow extended (in order to relax the muscle), pass the handle of the seeker from the lateral side of the arm along the course of the nerve upwards, through the tunnel that the lateral head makes with the humerus. Cut through the lateral head, then trace branches of the nerve to the lateral and medial heads, and, through the medial head, to the **Anconeus.** Establish the continuity of the radial nerve from axilla to cubital fossa. The **profunda artery** divides into two branches: one following the radial nerve; the other, behind the septum, following the posterior cutaneous nerve of the forearm. Appreciate this distribution and, if your subject is well injected, demonstrate it. The insertion of the Triceps into the olecranon will be studied with the elbow joint. Its expansion, the **"tricipital aponeurosis"**, which covers the **Anconeus** should be defined now. This can readily be done if the lateral border of the Triceps be followed distally. The muscle fibers give place to an aponeurosis which, spreading out over the lateral epicondyle of the humerus, finally gains an attachment to the posterior border of the ulna, having completely hidden the Anconeus from view.

Now is a suitable time to dissect the shoulder joint on one side. See page 59.

THE FLEXOR REGION OF THE FOREARM

It has already been observed that the flexor muscles of the forearm arise, in the main, on the medial side of the elbow

from the medial epicondyle and its supra-condylar ridge. They occupy an area which extends as far dorsally as the posterior border of the ulna which is palpable throughout its entire length. Thus, this border is the limit of the flexor region and separates it from the extensor region.

The original large single muscle mass splits tangentially to produce layers and, by a second process of longitudinal splitting, several individual muscles come into existence in each layer. The tendons of the resulting muscles are spread across the wrist from ulnar to radial side and whilst some confine themselves to the wrist region as carpal flexors, others reach to the free fingers (and thumb) as digital flexors.

The **brachial artery** divides just distal to the elbow joint into two terminal branches—**radial** and **ulnar arteries**—devoted to their respective sides of the forearm, whilst the median nerve maintains its midline position and between two of the layers. The ulnar nerve, coming from behind the medial epicondyle, joins the ulnar artery which it then accompanies.

The dissector first determines the relative positions of the tendons, vessels and nerves at the wrist level. It then becomes a simple matter to identify and isolate each individual muscle by tracing each tendon proximally.

Keep a radius and an ulna beside you.

Remove a segment of deep fascia about $1\frac{1}{2}''$ wide across the front of the wrist immediately above the skin-cut. Identify there the following structures, first on your own wrist, and then on the subject; then clean them within the $1\frac{1}{2}''$ limits. From lateral to medial side they are: **radial artery,** tendon of the **Flexor Carpi Radialis, median nerve, Palmaris Longus** (if present), **Flexor Digitorum Sublimis, ulnar artery** and **nerve** and **Flexor Carpi Ulnaris.**

Don't waste time looking for the *palmar cutaneous branches of the median*, of the *ulnar* and of the *lateral cutaneous nerve of the forearm* but review your knowledge of them. Remove any remains of the superficial fascia from the front of the forearm, and remove the deep fascia from the anterior and medial aspects of the forearm as far round as the posterior border of the ulna. This border is the dividing line between flexors and extensors. In the furrow medial to the Brachio-radialis pick up the **superficial branch of the radial nerve,** and follow it along the anterior border of the Extensor Carpi Radialis Longus until it passes deep to the tendon of the Brachio-radialis, and outcrops 1″ to 3″ above the styloid process of the radius. Its cutaneous distribution will be followed later. Pick up the brachial artery and trace it to its division into **ulnar** and **radial arteries.** Follow the radial artery to the wrist and, in doing so, note its relations, particularly the muscles that it successively crosses, and observe its branches: **radial recurrent**—turning upwards along the course of the radial nerve; *muscular*; *anterior carpal*—contributing to the anterior carpal arch on the bony plane at the lower end of the radius; *superficial palmar*—contributing to the superficial palmar arch and running downwards across the ball of the thumb.

Pick up the **median nerve**, observe once more its branches to the flexors (arising from its medial side) and follow it to where it passes deep to the humeral head of the Pronator Teres. It is there separated from the ulnar artery by a slip of that muscle, the *deep* (ulnar) *head of the Pronator Teres.*

Define, and with a sharp knife isolate, the following muscles: **Pronator Teres, Flexor Carpi Radialis, Palmaris Longus** and **Flexor Carpi Ulnaris.** To do this the last three muscles should be traced upwards from their tendons, already found at the wrist, and freed from each other along inter-

muscular septa and from the underlying Flexor Digitorum Sublimis. When defining the Flexor Carpi Ulnaris, you will see the ulnar nerve and artery under shelter of its tendon. Follow the **dorsal cutaneous branch of the ulnar nerve** and the *posterior carpal branch of the ulnar artery* deep to the tendon, below the styloid process of the ulna, and across the medial ligament of the wrist. The cutaneous distribution of the nerve will be followed later. As you split the septum between the Flexor Carpi Ulnaris and the Flexor Digitorum Sublimis, you are working in an internervous line (between ulnar and median nerve territories). On reaching a point about 2½″ below the medial epicondyle, be cautious lest you damage branches of the ulnar nerve to the Flexor Carpi Ulnaris and to half the Flexor Digitorium Profundus. As you clean the Flexor Carpi Ulnaris from below upwards, notice its origin from the medial epicondyle, the medial border of the olecranon, and the posterior border of the ulna. The humeral and the ulnar origins are separated by the ulnar nerve where it enters the forearm from behind the medial epicondyle. Follow the nerve upwards to establish its continuity. Trace the fleshy origin of the Pronator Teres some distance up the medial supracondylar ridge and define its fibrous insertion into the lateral surface of the radius. The insignificant deep (ulnar) head may be followed up to the coronoid process. Define the **Flexor Digitorum Sublimis.** If necessary, but not otherwise, cut the Pronator Teres and even the Flexor Carpi Radialis and Palmaris Longus. If you cut the muscles, do so at different levels to aid in their later re-identification. Just above the wrist pass the fingers behind the Flexor Digitorum Sublimis and ease it forwards being careful not to tear the thin radial origin. Look for the median nerve clinging to its deep surface. Free the nerve from the muscle and see its twigs of supply. The nerve be-

comes superficial on the lateral side of the muscle near the wrist. Follow the muscle both on its superficial and deep surfaces to its oblique origin.

Supinate the hand and retract the superficial flexors medially, thus opening widely the floor of the **cubital fossa.** The floor consists medially of the **Brachialis** and laterally of the **Supinator,** which latter envelops the radius above the Pronator Teres. Follow the **median nerve** deep to the bridge that spans the interval between the radial and humero-ulnar origins of the Flexor Digitorum Sublimis. Establish the continuity of the nerve throughout. Its **interosseous branch** arises with the branches to the superficial flexors and passes separately deep to the bridge.

Follow the **ulnar artery** deep to the Flexor Digitorum Sublimis where it has already been seen approaching the ulnar nerve. Clean it and its branches in the cubital fossa: **anterior ulnar recurrent**—passing upwards to the front of the medial epicondyle; **posterior ulnar recurrent**—passing upwards to the back of the medial epicondyle; (these two may arise by a common stem and the posterior is the larger) **common interosseous**—a short stem passing to the upper border of the interosseous membrane and dividing into two vessels, one on each side of that membrane. Clean the branches of the ulnar artery in the neighborhood of the wrist: *anterior carpal*—lying on the skeletal plane and uniting with the corresponding branch of the radial, already seen; *pos terior carpal*—already identified.

Flex the wrist in order to slacken the Flexor Digitorum Sublimis and then raise the muscle from the two deep flexor muscles: the **Flexor Pollicis Longus** arising from the radius, and the **Flexor Digitorum Profundus** from the ulna. The two muscles meet on the **interosseous membrane** therefore separate them in order to expose this membrane with the

anterior interosseous nerve and **artery** descending on it to the **Pronator Quadratus,** which runs transversely from the lower one quarter of the ulna to that of the radius. After supplying twigs to these three deep muscles, the nerve and artery disappear behind the Pronator Quadratus. Insinuate the closed forceps deep to the Pronator Quadratus, thus raising it, and cut it vertically between the blades. By this procedure, which will be useful on many occasions, you avoid injury to the membrane and to the structures on it. Observe the anterior interosseous artery passing backwards through the membrane to the extensor territory.

THE HAND

The original muscle mass of the hand, like that of the forearm, is divided into layers. Of these the superficial layer is confined to the thumb and little finger as the **thenar** and **hypothenar** musculature respectively. In the middle of the palm there develop, instead of muscle, a thick fascial mass superficially—the **palmar aponeurosis**—and a set of tendons immediately deep to it. [A series of little muscles, the **Lumbricals,** do however develop in the central mass in association with the tendons.]

In the depth of the palm there exist two layers, one consists of a special muscle for the thumb—the **Adductor Pollicis,** the other consists of a series of muscles placed between the bones—the **Interossei.**

The vascular supply of the hand is by means of two arterial arches: a more superficial one, mainly formed from the ulnar artery, lies immediately deep to the palmar aponeurosis; a deeper one, mainly formed from the radial artery, lies on the skeletal plane in association with the Interossei. These arches are placed in the proximal portion of the hand and from

them a series of vessels runs distally parallel to the metacarpals. On reaching the clefts of the fingers the vessels split to provide digital branches for the contiguous sides of the digits.

The median and ulnar nerves share the nerve supply of the palm. A vertical line drawn down the palm of the hand which passes also down the middle of the ring finger divides the ulnar cutaneous area medially from the median cutaneous area laterally. Of the muscles, the median nerve looks after the thenar mass whilst the ulnar nerve is distributed to the hypothenars and the deep layers.

Keep the bones of the hand beside you.

Make the following skin incisions: (1) down the middle of the palm as far as the webs of the fingers (fig. III, K to M); (2) across the palm at the webs of the fingers (fig. III, N to O); (3) down the middle of the thumb, ring and little fingers (fig. III, P). Remove the entire skin from the front and back of the hand except from the index and middle fingers. Additional cuts may be made if required.

Trace the basilic and cephalic veins distally to their beginnings in the *dorsal venous arch*. The **dorsal cutaneous branch of the ulnar nerve** and the terminal (**superficial**) **branch of the radial** have already been found. Trace them out and observe the pattern of cutaneous supply on the back of the hand. Verify your observations by reference to your text-book.

With your thumb nail feel the lateral border of the proximal phalanx of the index finger. Just behind this make a longitudinal cut through the skin and loose subcutaneous tissue (fig. III), raise forwards an anterior flap, and so find the **digital nerve** and **vessels**. This will demonstrate the position

in the fingers of the digital nerves. They lie on the sides of the fibrous sheaths of the flexor tendons, not on the sides of the bones.

Make a longitudinal incision through the skin and loose subcutaneous tissue down the middle of the front of the middle finger and reflect the flaps medially and laterally from the fibrous sheath. Find and establish throughout the length of this finger the positions of the digital nerves and vessels, i.e., verify what you found on the index finger. In doing this, note how thin the subcutaneous tissue is at the creases of the fingers. Leave the sheath cleaned throughout but unopened.

Three nerves are in danger as you proceed now to remove the fatty superficial fascia from the palm. These are: (1) **palmar digital nerve (and vessels) to the medial side of the little finger,** (2) **palmar digital nerve** (and vessels) **to the thumb;** (3) **"recurrent" nerve to the thenar muscles.** Deal with these at once by the following procedures. Trace and clean the ulnar nerve and artery until they pass deep to the fleshy **Palmaris Brevis** which lies superficially at the proximal part of the hypothenar eminence and is a thin quadrangular subcutaneous muscle of variable development. Remove any fat from the surface of this little muscle whose fibers run transversely. When it is cleaned, the digital nerve and artery, lying deep to a film of fascia and running obliquely distally from the lateral border of the pisiform to the medial side of the little finger, will easily be found. Trace them out. Dissect the expanding tendon of the Palmaris Longus free from the underlying flexor retinaculum to which it adheres, but do not follow it further into the palm at present. The **flexor retinaculum** is a strong quadrangular fibrous sheet whose transversely-running fibres are anchored to four bony pillars projected forwards from the four marginal carpal

bones. It thus acts as a bridge deep to which important structures enter the palm. Define with the point of the knife the upper (proximal) border of the **flexor retinaculum.** It extends from the tubercle of the scaphoid laterally to the pisiform medially. Pass the closed forceps deep to the retinaculum and separate from it the median nerve, which clings to its deep surface. (The nerve must be free to aid identification of the remaining nerves in danger.) Beginning at the lateral side of the hand, clean and raise the filmy fascia on the thenar muscles. At the medial border of this muscle mass and at the level of the metacarpo-phalangeal joint of the thumb, find the two palmar digital nerves and arteries to the thumb. Trace them distally as they proceed superficially, one on each side of the Flexor Pollicis Longus tendon; then trace them proximally and at the same time clean the medial border of the muscle mass. While this is being done the "recurrent" motor nerve to the thenar muscles will be found. It lies between fascia and muscle $1\frac{1}{4}''$ distal to the tubercle of the scaphoid and it takes a short recurrent course to enter the thenar muscles. Gentle tugs on the freed median nerve will help in locating this important branch. The distal concave border of the flexor retinaculum (in continuity with the muscle border just cleaned) should now be followed. It extends from the ridge on the trapezium laterally to the hook of the hamate medially. Remove any remaining fascia from the thenar muscles.

The three thenar muscles are: (1) **Abductor Pollicis Brevis**—strap-like and superficial; (2) **Opponens Pollicis**—deep to (1) and recognizable by the fact that it is inserted into the whole length of the metacarpal; (3) **Flexor Pollicis Brevis**—the smallest, and lying along the medial side of the Opponens from which it is not readily separable.

Identify the Abductor Pollicis Brevis, raise it, clean it to its

attachments and sever it at its middle. Separate the Flexor Pollicis Brevis from the Opponens, clean each to its attachments, then read an account of the thenar muscles.

Detach and remove the **Palmaris Brevis,** noting its twig of supply from the ulnar nerve. Be careful not to injure the underlying ulnar nerve and artery. More proximally a variable band of fibres—sometimes quite pronounced—crosses in front of the ulnar artery and nerve; sever it so as to leave artery and nerve free. Clean them and identify their deep branches. The **deep branch of the ulnar nerve** will be seen supplying the hypothenar muscles and plunging through the origin of the **Opponens Digiti Minimi** in contact with the hook of the hamate. Define the **three hypothenar muscles** which present similar dispositions to the thenar muscles. Review the details of the flexor retinaculum.

In the distal half of the palm, in line with the clefts between the fingers, the palmar aponeurosis is thin and its fibres transverse. These transverse fibres are the *superficial transverse ligaments of the palm* sheltering the structures at the clefts of the fingers. Cut the ligaments and, with the seeker, find deep to them the **palmar digital nerves** and **arteries** and the **lumbrical muscles.** These lie between the long digital flexors in their sheaths, and are in front of the **deep transverse ligaments of the palm** which in turn are in front of the Interossei. Follow the nerves and vessels to the fingers, where they have already been dissected.

Remove the fat from the **palmar aponeurosis** and study it; then reflect and remove it. Clean the median nerve. Its remaining two motor twigs supply **Lumbricals I and II** and spring from digital nerves. Clean the remaining digital branches of the ulnar nerve and find the communicating branch it gives to the median. Concurrently clean the ulnar artery, the **superficial palmar arch**—the continuation

of the artery—and the branches of this arch, i. e., the four **palmar digital arteries.** The manner in which the arch is completed laterally is variable. Unless its mode of completion is at once apparent leave it until the radial artery is dissected.

Clean the **fibrous flexor sheaths** of the tendons. Observe their proximal and distal limits. Remove the thin weak areas opposite the interphalangeal joints, and define the upper and lower edges of the two "tunnels."

At the wrist separate the Flexor Digitorum Sublimis from the Flexor Digitorum Profundus. Raise the Profundus and the Flexor Pollicis Longus from the Pronator Quadratus and from the prominent anterior margin of the lower articular end of radius. This will render obvious the upper limit of the **common synovial sheath** of the flexor tendons. You may puncture it and explore its limits. Clean the tendons above the wrist, removing the enveloping sheath. Separate the four tendons of the Flexor Digitorum Sublimis and, by pulling on each in turn, determine the fingers to which each runs. Of the Flexor Digitorum Profundus tendons, that for the index finger alone is free at this level.

Open all synovial flexor sheaths and verify the conditions relative to the tendons. In order to do this it will be necessary to cut one of the Profundus tendons near its insertion and to withdraw it from the sheath. The chief points to be observed are: (a) the level at which the Sublimis tendons split to let the Profundus tendons through; (b) the manner in which each half of a split tendon turns over, in part decussates, and finally is inserted. The peculiarities of this insertion ensure that the perforating tendon of the Profundus is never pinched; (c) the level of insertion of the Profundus tendon; (d) the **vincula**—the remains of mesotendons.

Identify the lateral side of the Lumbrical to the index finger

and the medial side of the long tendons to the 5th digit, then raise the mass between these two limits forwards from the palm, and observe a fibro-areolar septum connecting the mass to the anterior border of the middle metacarpal, and containing vessels.

Such an excellent view of the hand is obtained by the following procedure that you must carry it out. At the roots of fingers, 3, 4 and 5 cut the long tendons but not the corresponding Lumbricals. See that these long flexor tendons are free from their fibrous sheaths as far proximally as the flexor retinaculum, i.e., that the remains of all mesotendons are severed. Examine the origins of the Lumbricals from the Profundus tendons, detach these origins, and turn the muscles distally. One by one seize the tendons above the flexor retinaculum and withdraw them into the forearm. An "X-ray" view of the hand is now obtained. The superficial palmar arch, the palmar digital nerves and vessels, the long tendons of the index finger, the 1st Lumbrical and the Flexor Pollicis Longus remain. By working between these structures the **deep branch of the ulnar nerve** is easily traced across the palm. Accompanying it is a twig, the *deep branch of the ulnar artery*, which completes the **deep palmar arch** medially. This arch will be investigated in a moment.

Clean the **Adductor Pollicis** (the triangular muscle running from the 3rd metacarpal to the thumb). Pull the thumb forwards, see and open the space between the Adductor Pollicis and the **first Dorsal Interosseous.** In this space find the chief digital branches of the radial artery to the thumb and index; they are **princeps pollicis** and **radialis indicis.** The arterial pattern here is somewhat irregular and you may find one of these branches completing the superficial palmar arch. (If you have difficulty finding these vessels,

trace the already identified digital vessel of the index finger proximally.)

Follow the radial artery from the point where it appears in the palm between the two heads of the first Dorsal Interosseous muscle, thence between the two heads (oblique and transverse) of the Adductor Pollicis to its continuity with the **deep palmar arch.** Clean this arch and its branches: (1) **palmar metacarpals**—in series with the princeps pollicis and radialis indicis, (2) **perforating**—passing to the dorsum of the hand, and (3) *recurrent*—anastomosing with twigs from the anterior carpal arch. Leave the Interossei until the back of the hand is dissected.

Explore the **sheath of the Flexor Pollicis Longus** and note how delicate it is. Trace the tendon of the **Flexor Carpi Ulnaris** to the pisiform bone and onwards as the **piso-hamate** and **piso-metacarpal ligaments.** The tendon of the Flexor Carpi Radialis cannot be investigated until the flexor retinaculum is cut. This should not be done until after the hand has been reviewed and the joints are about to be dissected.

THE EXTENSOR REGION OF THE FOREARM AND THE BACK OF THE HAND

It has been observed that the extensor musculature of the forearm arises from the lateral epicondyle of the humerus and its supra-condylar ridge, and that it extends to the posterior border of the ulna. Like the flexors it is divided into layers and the tendons of the muscles of the superficial layer reach across the wrist from side to side, some confined to the wrist as carpal extensors, others proceeding to the free fingers as digital extensors.

The arrangement of the muscles of the deep layer is a little different from anything yet encountered. To understand its

disposition it is well to recall that in the movement of supination the ulna is the fixed bone whilst the radius moves freely. This deep layer is chiefly concerned with supination, not only of the radius but also of the thumb. That is why, when the hand is turned palm up, the thumb is usually extended. Hence the deep extensors arise, in series from above downwards, from the ulna. A strip of ulna adjacent to the interosseous border is devoted to them. From there they either insert on the radius or cross it (where they may gain additional origin) on their way in turn to each of the three joints of the thumb. An insignificant muscle indeed goes, not to the thumb, but to the index finger. Thus it comes about that a continuous muscle mass passes obliquely downwards and lateralwards from the ulna. In the lower half of the forearm this deep layer 'outcrops' by separating the superficial layer into a medial and a lateral group.

The nerve supply of all the extensors is the radial nerve. No large vessel is found posteriorly but the region is nourished by vessels that perforate from the front.

On the back of the hand the bones are almost superficial, hence there is little here to engage the dissector's attention other than the long extensor tendons and the contributions they receive as they pass to the free digits. Here too the vascular supply is insignificant and is derived from that part of the radial artery which makes a brief appearance in the region of the "snuff-box."

The cutaneous nerve supply of the back of the hand is shared by the radial and ulnar nerves. In the region of the terminal phalanges the median nerve replaces the radial.

The cephalic vein and the terminal branch of the superficial radial nerve crossing the "snuff-box" have been identified. The **Abductor Pollicis Longus** and the **Extensor Pollicis**

Brevis bound the snuff-box anteriorly; the **Extensor Pollicis Longus** bounds it posteriorly. Identify these three tendons and clean them distally from the lower end of the radius to their insertions. Find on the floor of the snuff-box the vertically running **radial artery.** Trace it to the upper end of the first intermetacarpal space where it disappears between the two heads of the **first Dorsal Interosseous.** Preserve its three or four small branches on the back of the hand, which, applied to the skeleton, run medially as the *dorsal carpal artery* and distally as the *dorsal digital arteries* (dorsales pollicis et dorsalis indicis) to carpus, thumb and index respectively. These small vessels are often not well injected and, in consequence, their display is somewhat unsatisfactory. In that case you should consult an atlas for their distributions.

The deep fascia at the back of the wrist is thickened to form the **extensor retinaculum.** Clean it and define its oblique upper and lower borders. All the tendons at the back of the wrist are in synovial sheaths, which mostly extend 1″ above and 1″ below the retinaculum. These sheaths should be noted later when the extensor retinaculum is slit to reveal the tunnels in which the tendons lie.

Trace proximally into the forearm the three tendons bounding the snuff-box. They are seen to give place to fleshy bellies which outcrop on the surface along a furrow which separates the superficial muscles of the extensor region of the forearm into a lateral and a medial group. Open up this furrow as far as the lateral epicondyle of the humerus. In doing this, it is necessary to split the intermuscular septum between the **Extensor Carpi Radialis Brevis** (of the lateral group) and the **Extensor Digitorum** (of the medial group). On separating and raising these two superficial muscles, the three outcropping muscles are seen arising deeply and

the **Supinator,** which lies above them, is seen wrapped around the upper third of the radius. Identify the **posterior interosseous nerve** emerging from the Supinator $2\frac{1}{2}''$ below the head of the radius and at once sending branches to: the medial group of superficial muscles, the three outcropping thumb muscles and the **Extensor Indicis** (to be seen later), also a long terminal branch to the wrist and carpal joints.

Read an account of the **deep fascia;** note its attachment to the posterior subcutaneous border of the ulna, already seen to be the medial boundary of this region; and note again the accession of fibers the fascia receives from the Triceps. Remove the deep fascia from below upwards to the point at which muscles arise from it (approximately the lower two thirds).

Identify, clean and study the superficial group of extensor muscles in the following order:

Lateral Group—**Brachio-radialis, Extensor Carpi Radialis Longus** and **Extensor Carpi Radialis Brevis.**

Medial Group—**Extensor Digitorum (Communis), Extensor Digiti Minimi, Extensor Carpi Ulnaris** and **Anconeus.**

Pick up the radial nerve and its two terminal branches (posterior interosseous and superficial radial) in front of the elbow joint. Trace branches from the radial and posterior interosseous nerves to the three lateral muscles and to the Supinator, and note the latter nerve entering the Supinator. Follow the three lateral muscles upwards to their origins and downwards to their insertions: the **Brachioradialis** to the base of the styloid process of the radius; the **Extensor Carpi Radialis Longus** to the posterior aspect of the base of the 2nd metacarpal and the **Extensor Carpi Radialis Brevis** to the posterior aspect of the base of the 3rd.

Before the remaining extensor tendons are followed to

their insertions, clean the deep fascia on the back of the hand. Then make a 1″ vertical cut through it down the middle of the back of the hand and, with the handle of the knife explore the extent of the **subaponeurotic space** so opened. The tendons lie, indeed they develop, in this deep fascia.

Of the medial muscles, the **Extensor Digitorum** has already been identified; the **Extensor Digiti Minimi** appears as a detached medial portion of the Extensor Digitorum and passes through a special tunnel behind the inferior radio-ulnar joint; the **Extensor Carpi Ulnaris** lies adjacent to the posterior border of the ulna and its tendon also passes through a special tunnel between the head and styloid process of the ulna. The two latter muscles are most readily identified by following their tendons proximally from the wrist. Raise the Extensor Carpi Ulnaris and inspect the smooth bed formed for it by the ulna. The **Anconeus,** triangular and fleshy, passes from the lateral epicondyle to the upper quarter of the posterior aspect of the ulna. Its lateral border is free; raise it and, in a well injected subject, see the **recurrent branch** of the posterior interosseous artery ascending on the ulna. This will be met again in the study of the elbow joint.

Slit in turn, by incising the extensor retinaculum, the tunnels for the tendons. Follow the flattened tendons right to their insertions, noting their cross-connections and their expansions. These expansions, and the Interossei and Lumbricals joining them from the palm, should be noted now. They will be studied in more detail when the tendons of the Interossei and Lumbricals are dealt with. When the Extensor Digitorum is freed from the retinaculum, it can be retracted medially and the five deep muscles cleaned and studied in their entirety. These are: **Supinator, Abductor Pollicis Longus, Extensor Pollicis Brevis, Extensor Pollicis Longus** and **Extensor Indicis.**

Clean the **posterior interosseous nerve** and **artery** and the terminal branch of the **anterior interosseous artery.**

The arteries on the back of the hand are insignificant and, unless the subject has been particularly well injected, they are difficult to display. If the dissector has trouble with them he should not delay but should at once consult his atlas or text-book. They are: (1) the *dorsal carpal arch* or rete, formed by the union of *posterior carpal branches* of the radial and ulnar arteries; (2) the *dorsal metacarpal arteries,* descending from the arch; and (3) their *digital branches.* Find the **perforating branches** coming through near the bases of the metacarpals to reinforce the dorsal metacarpal arteries.

Clean the bipennate **Dorsal Interossei** by removing the sheets of fascia covering them and lining the subaponeurotic space. Follow their tendons to the extensor expansions. Turn the hand over and follow the tendon of a Lumbrical to an expansion. In order similarly to follow the **Palmar Interossei** tendons it may be necessary to cut the deep transverse ligaments of the palm. Study now the details of the composition of the **extensor expansions** and the manner of their ultimate insertions. The chief points to note are:

1. The rounded tendons become flattened as they approach the free fingers.
2. They are joined on their sides by Interossei tendons.
3. More distally they are joined on their radial sides by Lumbrical tendons.
4. The expansion is wrapped round the dorsum and sides of the proximal phalanx.
5. The middle portion of the expansion—the original extensor tendon—is inserted into the base of the middle phalanx.
6. The side portions of the expansion—mainly the tendons of Interossei and Lumbricals—unite to be inserted into the base of the terminal phalanx.

7. The expansions are the sole protections of the backs of the joints they cross.

THE JOINTS OF THE UPPER LIMB

The objective in dissecting ligaments and capsules is to reveal those that, having strength, act as restraining bands or bonds of union between two bones. If the parts have become dry, it is well at this stage to use fluid, a few drops of water, to restore their suppleness and render them pliable again. Ligaments, when exposed, should be stroked along the course of their fibers with the point of the knife. This, by removing areolar tissue, renders their directions obvious. The exact sites of attachments must be defined by removing the surrounding periosteum and soft tissue with the square handle of the scalpel. It is a common fault to leave the attachments and edges of ligaments undefined.

Joints in Which the Clavicle Partakes. The dissection of the joints and ligaments in which the clavicle is involved must not be undertaken until the students working on the head and neck have completed their investigation of the anterior and posterior triangles of the neck. You may therefore have to leave this region for the time being and return to it later.

The origins and insertions of the muscles in the region must be reviewed. Descending from the neck in front of the **sterno-clavicular joint** is the tendinous insertion of the Sterno-mastoid; behind are the broad fleshy straplike insertions of the Sterno-hyoid and the Sterno-thyroid; the positions of the clavicular and sternal heads of the Pectoralis Major have already been studied. Remove all these, and note the unimportant *interclavicular ligament* joining the two clavicles across the suprasternal notch. Clean and note the direction of the fibers of the anterior part of the capsule (*sterno-clavicular ligament*) and also of the **costo-clavicular ligament** just

lateral to it. This latter ligament runs obliquely from the first costal cartilage to the inferior surface of the clavicle near its medial end.

Remove the Deltoid and Trapezius from the clavicle and acromion so as to leave the bones bare. Clean the **Subclavius** and, lateral to its clavicular attachment, feel the **conoid ligament.** Clean this inverted cone from behind. It passes from the conoid tubercle at the posterior border of the clavicle to the coracoid process beside the suprascapular notch. The cleaning can all be done with the seeker and the point of the knife. The **trapezoid ligament,** from the hinder half of the horizontal part of the coracoid, must be cleaned from in front. Its fibers are nearly horizontal and are contiguous with the conoid ligament. Define the triangular **coraco-acromial ligament.** Its base springs from the whole length of the lateral margin of the coracoid. Its apex is at the tip of the acromion. Clean both surfaces. Clean the capsule of the **acromio-clavicular joint.** If this is all well done you will appreciate how the important ligaments act in unison to prevent medial displacement of the scapula as they transmit forces, applied to the shoulder, to the medial two-thirds of the clavicle and thence to the sterno-clavicular joint. By manipulating these joints (e.g., raise the girdle, pull the humerus laterally, push it medially and rotate the scapula on the clavicle), demonstrate these restraining uses of the ligaments.

Open the sterno-clavicular joint from above, keeping the blade of the knife close to the manubrium. Display the **articular** disc and its attachments. Open the acromio-clavicular joint from above and observe the remnant of an *articular disc* in it. As you do this you will see that the capsular fibers are thickest above.

THE SHOULDER JOINT. Cut the Coracobrachialis and the short head of the Biceps close to their origin, and the long head of the Biceps in the bicipital groove. Cut the long head of the Triceps. Clean the insertion of the Subscapularis. Define the **coraco-humeral ligament.** It has an anterior free border extending to the lesser tuberosity and can be cleaned from in front only. It springs from the lateral border of the coracoid process in line with the Pectoralis Minor. Clean and follow the **Supraspinatus** under the bony arch. It can be lifted, with the handle of the knife, from the lateral part of the supraspinous fossa. Cut through it at its mid-length. The humerus can now be pulled well down from the acromion and even dislocated without rupturing the lax capsule. On pulling the lateral part of the Supraspinatus from under the bony arch, its broad flat tendon is found blending with the capsule. The cut end of the Infraspinatus must now be cleaned and the Teres Minor cut. Trace the insertions of these three muscles to their facets on the greater tuberosity.

The **fibrous capsule** is now completely exposed except in front, where the Subscapularis is left intact. Follow the proximal and the distal attachments of this tubular capsule. Make a vertical cut through its thin posterior part and from behind identify the following structures: (1) *superior, middle* and *inferior gleno-humeral ligaments*;—three ill-defined flattened bands reinforcing the front of the capsule. They tend to converge from the front of the anatomical neck on to the supra-glenoid tubercle. Between the superior and the middle is found the perforation leading to (2) the **subscapular bursa;** (3) the **long head of the Biceps.** Note the continuity of the tendon with the posterior part of the glenoid labrum.

Define the **transverse humeral ligament** bridging the bicipital groove and giving partial attachment to the coraco-

humeral ligament. Note this last ligament is taut in lateral rotation. Little is gained by cutting the Subscapularis, though by so doing the extent of its bursa behind its tendinous upper border is seen, as is also the fact that the muscle does not arise from the lateral part of its fossa.

THE ELBOW JOINT (AND SUPERIOR RADIO-ULNAR). Turn the flexors medially and the extensors laterally. Clean the Brachialis and define its margins.

Note: (1) the median nerve is separated from the capsule by the thin medial edge of the muscle; (2) the radial nerve is in contact with the capsule laterally; (3) the musculo-cutaneous nerve is lateral to the Biceps; (4) the brachial artery is on the medial side of the Biceps. Notice that the fibers of the Supinator embrace the insertion of the Biceps. Thus the radial artery passes from the Biceps immediately on to the Supinator.

Sever the Biceps and the four structures mentioned above, a few inches proximal to the elbow, and turn them down. Cut the Brachialis and, dissecting it off the capsule, trace it to its insertion into the coronoid process. Notice that the fibers of the Flexor Digitorum Profundus rise to the level of this insertion and in part embrace it. Thus the ulnar artery passes from the Brachialis immediately on to the Flexor Digitorum Profundus.

Expose the continuity of the ulnar nerve by cutting between the two heads of origin of the Flexor Carpi Ulnaris. The nerve here is in direct contact with the capsule. Cut across the Triceps 2″ above the elbow and dissect it off the back of the thin capsule. Trace it to its insertion into the olecranon and as the deep fascia covering the Anconeus. Observe and open the bursa deep to its tendon.

The **Anconeus** arises from the back of the lateral epi-

condyle. Its fleshy insertion extends from the olecranon to the bend in the posterior border of the ulna. Clean it. Then pass the seeker deep to the muscle and sever it along the seeker. When it is reflected, see once more the posterior interosseous **recurrent artery.** Now review the **anastomoses round the elbow.**

Strip upwards and remove from their origins the Pronator Teres, the Flexor Carpi Radialis and the Palmaris Longus. This will expose the origin of the Flexor Digitorum Sublimis in its entirety. It arises from humerus, ligament, ulna and radius along an oblique line. Remove its origin carefully and so expose the **medial ligament of the elbow** joint. Define the strong **anterior cord** and the weaker fan-shaped posterior part of this ligament.

Remove the Brachio-radialis and the Extensor Carpi Radialis Longus from the lateral supracondylar ridge and turn them down. Cut the Extensor muscles below the elbow and dissect up their common tendon of origin. Clean this origin from the lateral ligament of the elbow. Review the attachments of the **Supinator.** Slit it along the course of the radial nerve, which lies *in* the muscle covered only by a thin film of fibers. Working from the anterior border of the Supinator, with care remove the fleshy fibers of that muscle and so expose the **lateral ligament of the elbow joint.** Continuous with this fan-shaped ligament and suspended by it, is the **annular ligament** nearly encircling the head of the radius. Clean both ligaments and define their attachments. Notice that whilst the annular ligament is firmly attached to the anterior and posterior margins of the radial notch of the ulna it has such trivial attachment to the radius that the synovial sac extends well down on to the neck of the radius. This fact will be more fully demonstrated in a moment.

With the handle of the knife define the upper and lower limits of the **fibrous capsule.** Make transverse cuts through the capsule, both front and back (i.e., between lateral and medial ligaments), and explore the extent of the **synovial capsule.** Identify **Haversian glands** between the two capsules in the three fossae: coronoid, radial and olecranon. Sever the lateral ligament and, preserving the medial one, dislocate the joint medially. Notice the synovial folds particularly the extensive one between the head of the radius and the capitulum. Pass the probe carefully between the **annular ligament** and the radial head and explore the extent of the synovial sac described a moment ago as reaching well down on the radial neck.

THE INTERMEDIATE AND INFERIOR RADIO-ULNAR JOINTS. By severing the remainder of the muscles at the wrist, front and back, and by stripping them upwards, the **interosseous membrane** is uncovered. Clean and study it.

Strip the tendons down so that the wrist joint is clear. Cut through the annular ligament (at the elbow) and release the head of the radius. Pass the knife above the interosseous membrane and slit it down. Carry the knife onwards through the sac-like recess—recessus sacciformis—into the **inferior radio-ulnar joint** and then, avoiding injury to the **articular disc,** medially beneath the head of the ulna. Swing the radius laterally and view the **articular disc,** noting the ligamentous nature of its attachment to the ulna.

THE WRIST JOINT. Clean the front and back of the capsule. Note the direction of the fibers of the **anterior** and **posterior radio-carpal ligaments.** Clean the **medial** and **lateral ligaments.** They descend from the tips of the styloid processes to the marginal bones of the carpus. Forcing the

hand backwards, open the joint transversely immediately below the prominent anterior margin of the lower articular surface of the radius, and of course keep below the triangular disc. Extend the incision medially and laterally so as to leave the hand attached merely by the posterior part of the capsule. Swing the hand backwards on this as a hinge.

Note any synovial folds and the following: (1) the articular surface of the lunate equals in size that of the scaphoid; (2) the triquetral area is trivial; (3) the joint commonly communicates with the radio-ulnar joint above through a perforation in the disc, and with the intercarpal joints below through perforations in the inter-articular ligaments between the scaphoid and the lunate and between the lunate and the triquetrum; (4) the joint may also communicate with the piso-triquetral joint; (5) only in adduction does the triquetrum come into contact with the disc.

The Small Joints of the Hand. Slit the tunnel for the Flexor Carpi Radialis in the flexor retinaculum. Trace the Flexor Carpi Radialis through its special tunnel in the retinaculum and down the vertical groove beside the ridge on the trapezium. Note its laterally placed meso-tendon, and that the tubercle of the scaphoid acts as a pulley at the entrance to the vertical tunnel which leads straight to metacarpal II. Remove the retinaculum from its four bony attachments.

Review the insertions of the five carpal flexors and extensors. Remove from the front and back of the hand all remaining nerves and vessels and all fleshy fibers except those of the Interossei. Notice the spiral course of the Flexor Pollicis Longus tendon around that of the Flexor Carpi Radialis.

Grasp the scaphoid and the lunate and notice the movements possible at the mid-carpal joint. Clean the **inter-**

carpal, carpo-metacarpal and **inter-metacarpal ligaments** both front and back. Notice their directions. All joints are to be opened from in front. First open the **mid-carpal joint** by entering the knife between the tubercle of the scaphoid and the ridge on the trapezium, and causing it to follow a sinuous course medially. Note any synovial folds. Next open the **carpo-metacarpal joints** and, in that of the thumb, observe the loose capsule with parallel fibers. Manipulate the metacarpal bones, noting the increasing range of movement as you proceed from the second to the fifth.

Cut the intercarpal ligaments, observing the powerful one between the capitate and the hamate. Cut the **anterior intermetacarpal ligaments** and examine the articular facets.

All bones are now well displayed, attached only by a dorsal mat of ligaments, therefore, do not fail to read again an account of these bones seen for the first time in their fresh cartilage-covered state. Recall that, in the clefts between the fingers, the lumbrical muscles and the digital nerves and vessels pass in front of, and the Interossei behind, the **deep transverse ligaments of the palm.** Define the upper and lower borders of one of these quadrate ligaments and free its posterior surface. Observe that on each side it is continuous with a much thicker structure, the **palmar ligament** (palmar plate) which lies in front of the head of a metacarpal and which forms the upper limit of the posterior wall of the fibrous digital flexor sheath.

Cut one or more of the deep transverse ligaments. On each side of one finger remove the fleshy fibres of the Interossei and throw downwards the dorsal expansion of the extensors. Clean the **collateral ligaments** of a **metacarpo-phalangeal joint.** These little fan-shaped ligaments are important. Their eccentric attachments to the metacarpal heads account for the fact that as flexion progresses the ability

to abduct and adduct is progressively eliminated. Verify this.

Flex the joint and open the thin dorsal part of the capsule between the collateral ligaments, and so expose the head of the metacarpal. Now hyper-extend the joint until the metacarpal head breaks through the front of the capsule. Notice what happens to the palmar ligament: it separates from its insignificant metacarpal attachment and remains attached to the base of the phalanx and the collateral ligaments.

Cut *one* collateral ligament and examine the joint and the deep surface of the palmar ligament. The same general procedure should be carried out for the two **interphalangeal joints.** Notice however, that the shapes of their surfaces are different. These are hinge joints.

CHAPTER III

THE ABDOMEN

THE ANTERIOR ABDOMINAL WALL

The contents of the abdominal cavity are protected in front by a wall made up of layers. It is the duty of the dissector to investigate each of these layers in turn. He will be well advised to acquaint himself with their general arrangements at once.

The greatest protection is afforded by flat (oblique) muscles disposed in layers, in each of which the fibres take a direction different from those of the other two. As is the case everywhere else, the muscles are enclosed in a fascial covering. Therefore, superficial to the muscles lies one membranous layer of fascia and deep to them lies another. The membranous layers are separated on the one hand from the skin and on the other hand from the peritoneum by a layer of fat of variable thickness. Thus it comes about that whether we examine the wall from without-in or from within-out the same layers are met and in the same order. The layers named from without inwards are:

1. Skin, possessing the same characters as skin elsewhere.
2. Fatty layer (Camper's fascia). } Superficial fascia.
3. Membranous layer (Scarpa's fascia). }
4. **External Oblique** }
5. **Internal Oblique** } The flat muscles.
6. **Transversus** }
7. Membranous layer (**Transversalis fascia**).
8. **Extra-peritoneal fatty layer.**
9. **Peritoneum.**

On either side of the mid-line extending down the length of the anterior abdominal wall the three flat muscles are replaced by a single strap-like muscle enclosed in a sheath provided for it by the aponeuroses or flat tendons of the flat muscles. This is the **Rectus Abdominis.**

The principal vessels and nerves pursue their courses between the two innermost of the three oblique muscles, having pierced transversalis fascia and Transversus to attain this plane. The cutaneous branches of these vessels and nerves make their way successively through the two outermost muscles and their superficial membranous covering to ramify in the fatty layer of Camper deep to the skin.

In the male the essential organs of generation, the **testes,** are housed in a special out-pouching of the anterior abdominal wall known as the **scrotum.** This out-pouching involves only skin and fascia and here the fascia loses its fat, its place being taken by (cutaneous) muscle fibres, the **Dartos,** which, therefore, is continuous with the superficial fascial layer of the abdominal wall. On each side a peritoneal evagination, the **processus vaginalis,** descends through the remaining layers of the abdominal wall to line its own half of the scrotum. It early loses its connexion with the abdominal peritoneum and, as a little completely enclosed sac, is invaginated by a testis.

Each testis, with its duct and associated vessels and nerves, lies in the foetus, on the posterior abdominal wall in the extra-peritoneal fatty layer where it developed. By the time of birth it has migrated, made its way through transversalis fascia and the three flat muscles or their aponeuroses and, carrying as coverings an evagination from each, it has finally reached the interior of the scrotal sac, where, as already noted, it invaginates the processus vaginalis to secure for itself a peritoneal investment. The region of the anterior abdominal

wall traversed by the testis in its descent will, of course, engage the dissector's particular attention.

The state of affairs existing in the female can better be understood after the male has been investigated.

Palpate the following landmarks:

1. **Xiphi-sternal junction,** at the lower end of the body of the sternum.
2. **Pubic symphysis,** marking the lowest limit of the anterior abdominal wall in the midline.
3. **Pubic crest,** extending laterally from the symphysis.
4. **Pubic tubercle,** at the lateral end of the crest.
5. **Inguinal ligament,** stretching across the root of the thigh from the pubic tubercle.
6. **Anterior superior iliac spine,** the lateral attachment of the inguinal ligament.

If not already done make a midline skin incision from the xiphi-sternal junction to the symphysis pubis, encircling the umbilicus (fig. V, C to E). Then make a transverse incision from the upper end of the vertical one, lateralwards till stopped by the table (fig. V, C to D). From the lower end of the vertical incision carry a third cut, first along the pubic crest, then to the anterior superior iliac spine, following just below the course of the inguinal ligament, and thence along the iliac crest till again stopped by the table (fig. V, E to F). Reflect the skin of the abdomen laterally.

In the **superficial fascia,** which may contain much fat or be almost devoid of it, observe and trace, keeping strictly within the limits of the skin incision: (1) the **superficial epigastric vein** passing downwards from near the umbilicus; (2) the **superficial circumflex iliac vein** passing medially from the region of the iliac crest. Do not at this stage follow these veins below the lower skin incision. Later they will be seen

to end, a little below the inguinal ligament, in the long saphenous vein—a large cutaneous vein of the lower limb. Another vein—the *thoraco-abdominal vein*—may commonly be observed passing upwards from near the umbilicus to the axilla; its importance lies in the fact that it joins the superficial epigastric vein to the lateral thoracic vein and therefore connects the veins of the lower half of the body with those of the upper half.

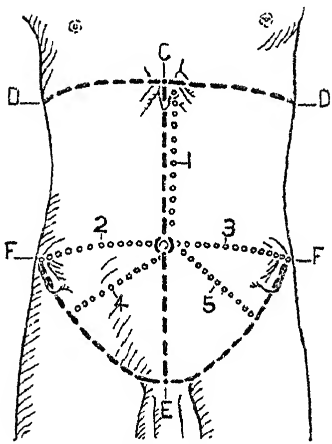

FIG. V

Beginning at a point a finger's breadth above the iliac crest and two inches behind the anterior superior iliac spine, make a one-inch incision extending downwards and medially through the superficial fascia until you see the fleshy fibers of the External Oblique muscle. (Here it is easy to distinguish the membranous layer of the superficial fascia from fleshy fibers; more medially the muscle becomes aponeurotic and the distinction between fascia and aponeurosis is diffi-

cult.) When you are satisfied that you have reached the proper plane, continue the incision to a point in the midline $1\frac{1}{2}$ inches above the upper end of the symphysis pubis. Be sure not to injure the underlying aponeurosis of the External Oblique. You will observe that the fat is thicker near the midline than on the flank.

Whilst the membranous layer of the superficial fascia contributes to the structure of the scrotum where, intermingled with muscle fibres, it is known as the **Dartos muscle**, yet it nowhere invades the lower limb. It ends by being attached to the **fascia lata** (i.e., deep fascia of the thigh), anteriorly along a line about a finger's breadth below the inguinal ligament and medially along the front of the pubis and pubic arch, i.e., along the line where the skin of the scrotum and skin of the thigh are continuous. At the back of the scrotum it will be met again in the perineum.

In order to verify these facts raise the lower cut edge of the superficial fascia, and insert the index finger deep to it, i.e., between the **membranous layer of Scarpa** and the **aponeurosis of the External Oblique.** After the lower portion of the superficial fascia has been raised, incise it in the midline down to the upper border of the symphysis pubis, in order to gain more room. With sweeping movements of the finger, aided by the rounded handle of the knife, demonstrate first the line below the inguinal ligament along which your finger is prevented from descending into the thigh. Then, having identified the **spermatic cord**—the group of structures that issue from the anterior abdominal wall and cross the pubic tubercle to enter the scrotum—insinuate the finger downwards, lateral to the cord, where it will be conducted into the scrotum but will be unable to pass laterally into the thigh.

Observe that, above the symphysis pubis, the finger is prevented from crossing the median plane by a mass of

fibro-elastic tissue, the **suspensory ligament of the penis,** which is attached above to the symphysis pubis and lower part of the linea alba; below, the ligament forms a sling for the penis and sends fibers to end in the scrotum.

Incise the superficial fascia by a vertical cut 2″ from the midline, and with the rounded handle of the knife detach it medially for about 1″ until the **anterior cutaneous nerves,** in series with those on the front of the thorax, are found; these are the terminal twigs of the anterior rami of the lower six intercostal nerves. About $1\frac{1}{2}''$ above the pubic crest the lowest member of the series is met. It is the **anterior cutaneous branch of the ilio-hypogastric nerve** (L.1).

The **External Oblique** muscle arises a full hand's breadth above the costal margin. Clean its fleshy digitations, one from each of the lower eight ribs. Between the sites of origin of the digitations of the External Oblique appear the **lateral cutaneous nerves** (T.7 to 12). Each nerve may be seen to divide into a quite small posterior branch that turns backwards over the Latissimus Dorsi and runs but a short distance, and into a much larger anterior branch that provides a motor twig to the digitation in front of it (usually to its deep surface) and descends, in the superficial fascia, in line with the fibers of the muscle. Trace several of these anterior branches forwards on to the abdominal wall as far as is profitable to demonstrate their fields of supply.

After the nerves have been identified and cleaned, remove all remains of the superficial fascia except in the inguinal region where it has already been dissected off the External Oblique aponeurosis and should not further be disturbed.

Clean the surface of the **External Oblique.** Observe the extent of its muscular portion and of its aponeurosis. Identify the following structures pertaining to this muscle, and read an account of them:

1. **Inguinal ligament**, the free lower border of the aponeurosis of the External Oblique.
2. **Pectineal part of the inguinal ligament (lacunar ligament)**, consisting of those fibres of the medial end of the inguinal ligament that gain attachment to the pectineal line. It is triangular. Its lateral edge is free, and on its upper surface rests the spermatic cord. It will be seen to better advantage later.
3. **Superficial inguinal ring**, a triangular aperture in the aponeurosis of the External Oblique whose base is at the pubic tubercle. It is filled by the issuing spermatic cord and obscured by:
4. **External spermatic fascia**, a delicate, areolar, tubular prolongation of the External Oblique aponeurosis carried down as the outermost covering of the spermatic cord. When this fascia is dissected free of the aponeurosis the boundaries of the superficial ring are apparent as:
5. **Superior and inferior crura.** The inferior crus is the more important for it is the medial end of the inguinal ligament and on it rests the cord.
6. **Intercrural fibres** bind the two crura together. They are often a little hard to make out.

Define carefully the margins of the superficial inguinal ring by incising the thin external spermatic fascia prolonged as a tube around the cord. Identify the **ilio-inguinal nerve** which will be found issuing from the ring probably lateral to the cord. Do not further disturb the cord at this time.

The origin of the **External Oblique** from the chest wall has been studied. It possesses a free fleshy posterior border, but, in order to investigate this border and its associated structures, it is necessary to turn the body on to the side. Therefore, working with the co-operation of your partners on the opposite side of the body, turn the subject on to the

side, support it and 'open up' the flank by the judicious use of blocks and posture. The External Oblique is inserted into the anterior half of the iliac crest, therefore the **lumbar triangle,** which is situated above the crest between the External Oblique and the Latissimus Dorsi, lies behind the midpoint of the crest. Find this midpoint by palpating the anterior superior and posterior superior iliac spines. The fibers of the Latissimus take almost the same direction as those of the External Oblique, so you must be careful in looking for the triangular interval between them. Indeed, actually there may be no interval between the muscles and hence no triangle. In any case, clean the adjacent borders of the two muscles and so define the triangle or, if none be present, separate the two cleaned fleshy borders and so create one. Observe the floor consists of fleshy fibers of the **Internal Oblique** (which therefore is attached to more than the anterior half of the iliac crest. Its fibers lie nearly at right angles to those of the External Oblique. Crossing the floor you *may* see the **lateral cutaneous branch of the ilio-hypogastric nerve,** provided the nerve has pierced the Internal Oblique so far back. Cut through the External Oblique parallel to, and one inch above, the costal margin right round to its free posterior border. Close to the iliac crest sever its attachment, being careful of the lateral cutaneous branch of the ilio-hypogastric nerve and, further forwards, of the **lateral cutaneous branch of T.12;** these two branches cross the iliac crest. When the muscle is lifted forwards, the underlying **Internal Oblique** is seen. It also has a free posterior border, except when its most posterior fibers arise from the aponeurotic origin of the Transversus. Indeed, this posterior border is thin, variable, and not easy to define. Whilst the subject is still on its side, remove these posterior fibers and observe the **ilio-**

hypogastric nerve piercing the aponeurosis of the Transversus. Its lateral branch has been seen. Its anterior branch runs forwards between the Transversus and the Internal Oblique close above the iliac crest—it has been seen above the pubic crest. It will be followed in its entirety later.

At this time it is highly instructive to follow the **anterior ramus of a spinal nerve** back to its origin, but this, of course, must not be done until the deep muscles of the back have been dissected. However, it is possible now to follow one well round in an intercostal space, and as far as these muscles. Choose the tenth which, issuing from the open end of the space between the 10th and 11th ribs, will later be seen running between the Internal Oblique and the Transversus towards the umbilicus. At the anterior end of this space observe the Internal Oblique in continuity with the Internal Intercostal. Pick up the nerve deep to the Internal Oblique and trace it backwards, well round the intercostal space.

Turn the subject on to its back again. The attachment of the External Oblique to the iliac crest has been severed. Continue the reflexion of the muscle by cutting through its aponeurosis to a point not less than ½″ above the symphysis pubis, keeping your cut well above the superficial inguinal ring in order to preserve it intact. Throw the muscle medialwards. Observe the only two nerves exposed: the **ilio-hypogastric** piercing the Internal Oblique about 1″ medial to the anterior superior spine and the **ilio-inguinal** below it. The one runs horizontally forwards; the other runs parallel to the inguinal ligament, about 1 cm. above it, and passes through the inguinal ring. Study the **Internal Oblique**.

At a level 2″ postero-superior to the anterior superior iliac spine separate the horizontally-running fibres of the Internal Oblique until deep to them you come upon a delicate areolar

sheet. In this sheet the terminal and the ascending branches of the deep circumflex iliac artery run upwards between Internal Oblique and Transversus. Having by this procedure determined the plane between the two muscles cut horizontally through the Internal Oblique, leave the portion of the muscle below the cut intact. The upper portion is to be reflected by detaching it from its origin from the iliac crest and from its insertion into the costal margin, and throwing it medialwards. The nerves cling to its deep surface; therefore, when reflecting it, free them, and notice their courses. Follow the tenth forwards to the umbilicus—it has already been followed backwards. Note that the nerves perforate the posterior wall of the Rectus sheath.

Leave the **Transversus** intact but study its attachments. Observe that the **ilio-inguinal nerve** pierces the Transversus at the origin of that muscle from the iliac crest about 2″ behind the anterior superior iliac spine, and runs close along the crest. Before the lower or inguinal portion of the **Internal Oblique** is reflected, observe its free arched lower border arising from the lateral half of the inguinal ligament Filling the concavity of this arch, from the middle of the inguinal ligament to the pubic tubercle, is the **Cremaster muscle.** Continue now the detachment of the fibers of the lower portion of the Internal Oblique from the iliac crest and inguinal ligament. In doing this, work cautiously in the areolar plane already found and keep lateral to (below) the ilio-inguinal nerve in order not to damage its muscular twigs, which, obviously, must pass medialwards. (This nerve can almost invariably be picked up lying in contact with the iliac crest where the Transversus takes origin.) As the Internal Oblique is being reflected, the ilio-inguinal nerve will be cut as will also the ilio-hypogastric, both of which pierce the muscle in front of the anterior superior spine. Render tense

the lower free margin of the Internal Oblique and trace it as a curved border to the pubic tubercle.

Pick up the lower free margin of the Transversus. Hold it forwards and upwards, and sweep the handle of the knife between it and the underlying **fascia transversalis.** In so doing, define a free curved edge passing behind the spermatic cord to be attached to the pectineal line (**pecten pubis**). This is the lateral part of the **conjoint tendon or falx inguinalis.** With the handle of the forceps press the inguinal ligament forwards and downwards in order to see that some fibers of the medial end of that ligament stretch posteriorly to be attached to the pectineal line. This is the **pectineal part of the inguinal ligament,** also called the **lacunar ligament.** The conjoint tendon lies vertically disposed and is a wall. The pectineal part of the inguinal ligament lies horizontally disposed and is therefore a floor.

A finger's breadth above the inguinal ligament, at the summit of the muscular arch just seen, is the mouth of an evaginated flimsy tube of fascia transversalis. The tube is the **internal spermatic fascia.** The mouth is the **deep inguinal ring.**

Make a transverse cut along the length of the fibers of the **Transversus** at the level of the anterior superior iliac spine. Detach the origin of the lower or inguinal portion of the Transversus from the inguinal ligament and reflect it medially. Observe it is thinner than the other two flat muscles. Deep to it is the **fascia transversalis,** and deep to this again is the **extraperitoneal fat, then peritoneum.** Observe the unequal distribution of the fat.

Confirm by observation: (1) that the fascia transversalis at the iliac crest is continued as the iliac fascia covering the muscle of the same name; (2) that the unopened peritoneal sac can be eased away from the iliac fascia; (3) that the

constituents of the spermatic cord (to be investigated later) adhere to the outer surface of the sac; (4) that, if a 1″ incision be made through the peritoneum, where it has been eased forwards, and a finger inserted, the sac-like nature of the peritoneum can be completely verified, as can the fact that the cord is outside the sac (i.e. extraperitoneal).

Turn now to the Rectus sheath. Keeping half an inch from the midline below the level of the umbilicus, but a full inch from the midline above that level, make a vertical incision through the anterior wall of the sheath of the Rectus extending from the pubic crest (medial to the tubercle) upwards to the cartilage of the fifth rib. The muscle is to be shelled out of its sheath. This is readily accomplished if the resistance encountered where the **tendinous inscriptions** adhere to the anterior wall of the sheath be overcome by the use of the knife. Observe the nerves piercing the lateral third of the muscle and verify their identities. When the muscle is free, raise it and divide it about its middle. Below, look for the **Pyramidalis.** It is a small triangular muscle, lying in front of the lower two or three inches of the Rectus Abdominis immediately above the pubic crest; it is commonly absent. Throw the two halves of the Rectus up and down and inspect its posterior surface. The **superior epigastric artery** will be observed adhering to the posterior surface of the muscle; follow it up to the seventh costal cartilage behind which it passes. Pick up the much larger **inferior epigastric artery** and follow it down to where it pierces the posterior wall of the Rectus sheath; then by pulling gently on the artery determine that it arises from the external iliac artery in the extraperitoneal fat at the mid-inguinal point, and that it passes behind the spermatic cord in company with its veins.

At the point where the inferior epigastric artery pierces the Rectus sheath is the **arcuate line.** It lies about midway

between the symphysis pubis and the umbilicus, and may be obvious or may require to be defined. The arcuate line indicates the level at which a change occurs in the disposition of the aponeurosis of the Internal Oblique. Above the line the aponeurosis splits to enclose the Rectus; below the line the aponeuroses of both Internal Oblique and Transversus pass in front of the Rectus leaving only transversalis fascia to form the posterior wall of the sheath. Verify this.

Examine the sheath in the midline observing that: below the umbilicus, the two Recti are separated by a thin partition—hence **"linea alba"**; above the umbilicus, the nature of the sheath prevents the muscles coming together—hence **"tinea alba."** Observe that the xiphoid process develops in the posterior wall of the sheath and that nerves pierce the lateral one-third of the posterior wall. Count these nerves.

Study the **Rectus Abdominis,** its sheath and the contents.

The Testis, Spermatic Cord and Scrotum. To display the testis and spermatic cord an incision, extending from the superficial inguinal ring to a point half way down the scrotum, should be carried through skin, Dartos and superficial fascia. The *superficial external pudendal vessels,* which cross in front of the cord on their way to supply the front of the scrotum, must be cut. The testis and cord, in their three coverings, are to be shelled out of the scrotum with the fingers by freeing the cord all round from areolar tissue; but it will be found that this cannot be done until a band of tissue, that anchors the coverings over the lower pole of the testis to the scrotum, is first snipped through. This band is perhaps a remnant of the **gubernaculum.** In it are some small veins.

In order to study the scrotal sac, pack it tightly with

cotton waste, observing first the median septum dividing it into two pouches. Endeavor next to demonstrate the following facts: (1) the fatty layer of the superficial fascia (Campper's fascia) is continued into the scrotal wall but looses its fat and contains muscle fibers, **Dartos muscle;** (2) the subcutaneous tissue of the scrotum is laminated. Later it will be seen that these layers are continued into the perineum.

If the specimen has been cared for, the three tubular *coverings* of the cord can be incised longitudinally one by one and separated from each other. The outermost, the **external spermatic fascia,** and the innermost, the **internal spermatic fascia,** are filmy areolar tubes; the middle also is areolar but contains loops of Cremaster muscle. Examine the *constituents* of the cord: first identify the **vas deferens** by its cord-like feel and posterior position; then free it and the attenuated **deferent artery** which clings to it; then free a larger artery, **the testicular,** which runs with the **pampiniform plexus of veins.** [It is possible to trace the **testicular** artery to the testis and to establish its anastomosis with the deferent artery.] Trace the vas deferens up to the deep inguinal ring and note it hooking around the lateral side of the inferior epigastric artery.

Begin the study of the **testis** by making a vertical incision through the "peritoneal" sac of the **tunica vaginalis testis,** in front of the organ. Inspect the interior of the sac; on the lateral side identify a canoe-shaped recess $\frac{3}{4}''$ long, the **sinus of the epididymis,** which separates the testis from the **body of the epididymis.** The fold bounding the sinus above corresponds to the lower limit of the efferent ductules. Look for rudimentary structures like pinheads, one attached to the upper pole of the testis, the other to the head of the epididymis: they are the *appendix of the testis* and the *appendix of the epididymis* respectively. The **visceral layer** of the sac covers

the testis and the **head of the epididymis.** Remove the fold of "peritoneum" bounding the sinus; then with scissors or sharp knife and by stroking with a seeker display the **efferent ductules,** which are finer in caliber than the lead of a pencil. Incise the sac all round at its reflection from the testis, including the bottom of the sinus; then, by blunt dissection commencing below, separate the epididymis from the testis right up to the ductules. In the process you will observe and sever several vessels entering the testis. If not done already, trace down the vas deferens and its artery, also the testicular artery.

Read an account of the structure of the testis. Then incise the front of the testis longitudinally from upper to lower pole and notice the thickness of its fibrous capsule, the **tunica albuginea.** The **seminiferous tubules** are easily shelled out of the capsule. When this is done, notice the highly tortuous branches of the testicular artery to be seen on the inner surface of the tunica albuginea. Working with two pairs of forceps, and with the testis preferably under water and against a black background, tease apart the lobules of the testis, noting the fine threadlike seminiferous tubules. Unravel the epididymis and note that the lower end of the vas deferens is dilated.

THE ABDOMINO-PELVIC CAVITY

The peritoneum is a thin, transparent, serous membrane and in order to understand its complexities certain fundamental facts must be appreciated:

1. It is a completely enclosed sac save in the female where it is pierced by the mouths of the uterine tubes.
2. It lines the walls of the abdominal cavity.
3. Immediately outside it there exists an extra-peritoneal fatty layer and in this layer the organs and their vessels develop and lie.

4. If an organ remains behind the sac it is merely covered in front with peritoneum; this, in general, is the state of affairs pertaining to the urinary system.
5. If an organ invaginates the sac it is invested by peritoneum and this outer investment is known as the **serous coat** of the organ; this, in general, is the state of affairs pertaining to the gastro-intestinal system.
6. The mobility of an organ will depend on the mode of its peritoneal covering or investment.
7. When an organ is mobile it is slung from the body wall by 2 layers of peritoneum. These layers are known as **a mesentery.**

   [Note: The word "mesentery" (meso-enteron) refers properly to the peritoneal layers slinging the gut or enteron. Hence the use of the prefix 'meso' followed by the name of the organ, e.g., meso-gastrium, meso-colon, mesovarium, meso-salpinx.]
8. The sole pathway to or from such a mobile organ lies between the two layers of its mesentery.
9. The two layers of peritoneum stretching between two organs are spoken of as a **peritoneal ligament** and the name of the ligament denotes the organs it connects, e.g., gastro-splenic and lieno-renal ligaments. Where the stomach is one of the organs the word **omentum** (apron) is used.
10. Where peritoneum abruptly changes its direction and at the same time passes from a fixed to a mobile condition or the reverse, it is thrown into **folds,** just as a sheet of cloth would be under similar conditions. Or, folds may be produced by the lifting of peritoneum from the body wall by blood vessels. Hence folds may be either bloodless or vascular. They bound **peritoneal fossae** and often are important.

11. The organs invaginating the peritoneal sac so encroach on its cavity as to reduce it to a mere potential space. Peritoneum everywhere is in contact with peritoneum; nothing exists in the interior of the sac save a little lubricating serous fluid. It is by this means that mobile organs can, and do, move on one another in a completely frictionless manner.

When the student has grasped the above fundamental considerations he may open the peritoneal vavity. Five incisions radiating from the umbilicus are to be made through fascia transversalis, extraperitoneal fat and peritoneum: (1) vertically upwards to the xiphoid process, keeping $\frac{1}{2}''$ to the left of the median plane (fig. V, 1); (2) and (3) a horizontal cut on each side (fig. V, 2 and 3); (4) and (5) an oblique cut on each side downwards to a point about an inch medial to the anterior superior spine of the ilium (fig. V, 4 and 5). Reflect the resulting five flaps and adopt suitable means to retain them well reflected so that the abdominal cavity is widely opened.

In order to understand the reasons for the existence of certain folds seen on the deep surface of the flaps it is necessary to appreciate the conditions obtaining in the embryo:

1. Blood returning from the placenta via the (left) umbilical vein made its way to the liver. Hence a fold to accommodate this vein is lifted off the anterior abdominal wall and extends from the umbilicus to the porta of the liver. This sickle-shaped fold is known as the **falciform ligament of the liver.** Examine it and in its free edge observe the **round ligament** (lig: teres) which is the remains of the umbilical vein.
2. The portion of the allantois lying within the abdominal cavity is represented by its remnant, the **urachus,** which

still runs from the umbilicus to the apex of the urinary bladder. It too may lift a midline fold of peritoneum off the anterior abdominal wall. Identify it.

3. Blood proceeded to the placenta from the aorta via the two **umbilical arteries.** Identify the remnant of these arteries seen in their peritoneal folds running from the sides of the bladder to the umbliicus. Their exact origins cannot be seen now.
4. The inferior epigastric artery running in the extraperitoneal fat may also lift up a fold of peritoneum. It has been seen running upwards and medialwards from about the mid-inguinal point. Its fold has no embryological significance. Read now an account of the umbilicus.

When these folds have been studied proceed to the investigation of the peritoneum. Do not dissect until the dispositions of the organs and their peritoneal attachments and relations have been mastered.

DISPOSITIONS OF THE ORGANS AND PERITONEUM. Identify the following structures:

1. **Diaphragm,** forming the roof of the abdomen.
2. **Liver,** lying above and mainly to the right side, and divided into a right and a left lobe by the falciform ligament which connects the liver to the diaphragm and to the anterior abdominal wall.
3. **Gall bladder,** lying at the lateral margin of the right Rectus Abdominis and in contact with the inferior (visceral) surface of the liver, and reaching to or beyond the sharp inferior border of the liver.
4. **Stomach,** situated above and to the left. It may be dilated and conspicuous or contracted and less evident. It is connected to the liver by the **gastro-hepatic or lesser omentum** (to be studied later) and from its

lower border or greater curvature hangs a large fatty peritoneal apron, the **greater omentum.**

5. **Spleen,** lying behind the stomach in contact with the Diaphragm and connected to the left part of the greater curvature of the stomach by a peritoneal fold, the **gastro-splenic omentum.**

Throw the greater omentum upwards over the costal margin in order to see:

6. **Small intestine,** a coiled mobile tube about twenty feet long and terminating by emptying into:
7. **Cecum,** the first and largest-calibred part of the large intestine and occupying the right iliac fossa. The **large intestine** frames the small intestine on three sides. The **ascending colon** runs upwards in the right flank from the cecum to the liver. The **transverse colon,** swinging across from right to left, is held to the back of the greater or **gastro-colic omentum.** The **descending colon** runs downwards in the left flank from the region of the spleen to the pelvic brim. The **pelvic colon** passes to the middle of the sacrum where it becomes the **rectum.**
8. **Transverse mesocolon,** that part of the greater omentum extending from the transverse colon to the:
9. **Pancreas,** a fragile organ extending horizontally across the posterior abdominal wall at the 'root' of the transverse mesocolon.
10. **Kidneys,** lying behind the posterior parietal peritoneum. The rounded lower halves can be made out as two smooth elevations below and medial to the two angles seen at the two ends of the transverse colon.
11. **Urinary bladder,** empty, flattened and lying behind the pubis.

Certain parts of the alimentary canal are not immediately

accessible, therefore before proceeding to its more detailed consideration the student is advised to consult his text-book and learn the names and general disposition of the parts of the canal in continuity.

Identify next the last inch of the **esophagus** for that is the only portion lying within the abdomen. It pierces the diaphragm about an inch to the left of the midline, occupies a groove on the posterior aspect of the left lobe of the liver and enters the stomach as the **cardiac orifice.** It is not very accessible at present. The exit from the stomach, the **pylorus,** is guarded by the **pyloric sphincter** whose presence may be appreciated by pinching the walls between thumb and index finger when a muscular thickening at the exit will be apparent. The upper border or **lesser curvature of the stomach** is short and concave and, with the first inch of the duodenum, gives attachment to the lesser or **gastro-hepatic omentum** which stretches from stomach to liver. It is more conveniently studied when the peritoneal attachments of the liver are investigated. The lower border or **greater curvature of the stomach** is long and convex and, with the first inch of the duodenum, gives attachment to the large peritoneal folds already identified as the **gastro-splenic** (to the left) and **gastro-colic** or **greater omentum.** Read an account of the stomach and its parts.

The **duodenum** immediately succeeds the stomach and is about 10 inches long. Its first inch is mobile and has already been noted in association with the omenta. The remainder of the duodenum is U-shaped and inaccessible just now. It is moulded round the head of the pancreas, lies against the posterior body wall and is retro-peritoneal. Its termination may be found an inch to the left of the midline by finding the upper end of the mobile portion of the small intestine which immediately succeeds it. The duodenum will be studied in more detail later.

The upper two-fifths of the free or mobile part of the small gut are called **jejunum,** the lower three-fifths **ileum.** The whole extends from the duodenal-jejunal junction whose site has been noted to the **ileo-colic orifice** where it enters the cecum. Identify this termination. Though a space of but 6 inches divides the two points, the gut, under dissecting room conditions, steers a varying course of 20 odd feet between them. The **root of the mesentery** of the gut is attached diagonally across the posterior abdominal wall between the two points and is, therefore, also six inches long, while its intestinal border is elaborately ruffled and frilled to accommodate the gut. The small intestine is so convoluted and mobile that you can pass many feet of it through your hands without being able to decide whether it is leading you to its duodenal end or to its cecal end. But, by the simple device of placing a hand on each side of the mesentery and drawing the fingers forwards from root to intestinal border, the convolutions are locally untwisted and the direction of the gut rendered quite obvious.

The first coil of the jejunum and the last coil of the ileum are parallel to each other; the former passes downwards and to the left in front of the left kidney, the latter passes upwards and to the right out of the pelvic cavity and across the external iliac vessels.

By holding forward suitable sections of the small intestine and inspecting the mesentery in a good light verify the following facts:

1. Fat, normally present in the mesentery, is more abundant in the ileal section of the gut than in the jejunal. It creeps along the vessels on to the ileal wall but, failing to reach the jejunal wall, leaves translucent "windows" in the mesentery at the edge of the jejunum.
2. The disposition of the vessels becomes progressively more complex from the beginning of the jejunum to the

end of the ileum; thus the **vasa recta** or straight terminal vessels to the upper section of the gut spring from a single system of arcades; to the lower section from a system of four arcades.

3. The vasa recta become progressively shorter and pass more or less alternately to opposite sides of the gut where they arborize but do NOT anastomose with one another.

Examine now the large intestine and observe the following features:

1. The outer longitudinal muscle coat is not complete but is arranged in three narrow bands, the **teniae coli,** which, being shorter than the gut itself, cause it to be gathered up into **sacculations** or **haustra.** Cut the teniae in one region and see the effect on the sacculations.
2. Peritoneal bags of fat, **appendices epiploicae,** hang from the large gut throughout its length. Most appendices are attached to the colon between its "inner margin" and the anterior tenia, but in the pelvic colon they are in two rows, one on each side of the anterior tenia.
3. Size alone does not necessarily distinguish large gut from small.
4. As a rule only the appendix and the transverse and pelvic colons retain their mesenteries. The degree of mobility of the ascending and descending colons depends on how complete is the loss of their mesenteries.
5. The rounded lower end of the cecum often hangs over the pelvic brim. It may have a short mesentery or even two mesenteries with a cul-de-sac, the **retrocecal fossa,** extending upwards between them.
6. The **vermiform appendix** opens into the cecum an inch or less below the ileo-cecal junction. It may occupy

any position consistent with its length. It is commonest retro-cecal, frequently pelvic, rarely elsewhere.

7. A triangular fold of peritoneum, the **meso-appendix,** attaches the length of the appendix to the termination of the ileum.
8. The three teniae begin at the base of the appendix which, like the small gut, has a complete longitudinal muscle coat.
9. The ascending colon reaches as high as the liver where, as the **right colic or hepatic flexure** it makes a right angle bend in front of the lower half of the right kidney.
10. The right extremity of the transverse colon is fixed and in contact with kidney, duodenum and pancreas. The left extremity is higher than the right, reaches the spleen and makes an acute angle bend as the **left colic or splenic flexure** to become the descending colon. This flexure is attached to the diaphragm by a bloodless fold of peritoneum, the **phrenico-colic ligament,** which forms a shelf to support the spleen.
11. The descending colon is longer than the ascending and usually of considerably smaller calibre.
12. The pelvic colon, of variable length, has a mesentery, the **pelvic meso-colon,** whose attachment to the posterior abdominal wall is in the form of an inverted V, one limb of which runs upwards along the pelvic brim, the other downwards in front of the sacrum to the third sacral vertebra, where the rectum begins.

Examine now the viscera in the upper region of the abdomen and their peritoneal connexions. In order to do this throw down again the transverse colon and greater omentum.

For purposes of examination **the liver** is said to possess five surfaces. Of these the **superior, anterior,** and **right lateral**

surfaces are continuous with one another, covered with peritoneum and applied to the diaphragm and anterior abdominal wall. The **posterior** surface, inaccessible just now, is moulded round the vertebral column and also applied to the diaphragm. The **inferior** or **visceral** surface bears the impress of every structure in contact with it and is separated from the large convex surfaces by the sharp inferior border.

The **gall bladder** consists of **fundus, body and neck.** Notice that when the other structures in the vicinity are in place the fundus is in contact with the anterior abdominal wall in front; the body with the transverse colon below and with the duodenum behind; the neck runs dorsally to the right end of the porta hepatis or doorway to the liver. Identify the **porta hepatis,** a transverse fissure in the inferior surface of the liver giving entrance or exit to vessels, nerves, and ducts. Trace around the margins of the porta the attachment of the right half of the lesser or gastro-hepatic omentum. Since the duct of the gall bladder, the **cystic duct,** enters the lesser omentum furthest to the right, by running the fingers along the gall bladder they are guided by that structure to the mouth of the lesser sac of peritoneum which lies behind the free right edge of the lesser omentum. Identify the mouth and the free edge.

Next follow the peritoneal attachments of the liver. The **falciform ligament** has already been identified. Pass a hand backwards on each side of it to where the peritoneum is reflected from the superior aspect of the liver on to the diaphragm: follow the reflexions to right and left to the respective **triangular ligaments,** where the peritoneum slides, as it were, off the extremities of the liver to the diaphragm. Appreciate that the right and left sheets of the falciform ligament have, in effect, been separated to accommodate the liver between them.

Identify the **round ligament** (lig: teres hepatis) in the free

edge of the falciform ligament then read an account of the manner in which the **ductus venosus** conveyed blood in the embryo from the umbilical vein to the inferior vena cava. When you understand this you will appreciate why it is you can trace the round ligament to the bottom of a fissure on the posterior surface of the liver and establish its continuity with the **ligamentum venosum.** The two ligaments occupy the two parts of the **sagittal fissure** which separates the small left lobe of the liver from the much more extensive right lobe. Thus the falciform ligament, the round ligament and the ligamentum venosum completely divide the liver into right and left lobes.

Verify now that the lesser omentum extends from the lesser curvature of the stomach and first inch of the duodenum to the fissure for the ligamentum venosum and around the porta hepatis.

The peritoneum, on passing from the diaphragm to the liver at the leftmost tip of the left lobe and at the lowest tip of the right lobe—which, are at opposite extremes of the liver—has to reach both the inferior surface and the great convex surface. The sharp, bloodless peritoneal folds that result are the **right** and **left triangular ligaments.** The **left triangular ligament** is an extensive fold which can be clamped between the right index and middle fingers. The **right triangular ligament** is less marked; its two layers at once diverge and, as the **upper** and **lower layers** of the **coronary ligament,** limit the **bare area** on the back of the liver above and below. The upper layer of the coronary ligament is reflected from the right lobe of the liver on to the diaphragm. It is continuous with the falciform ligament. The lower layer is reflected from the inferior surface of the liver on to the right kidney (and right adrenal gland, and inferior vena cava), so it is synonymously called the **hepato-renal ligament.** Below the hepato-renal ligament

is a peritoneal space called the **hepato-renal pouch** (of Morison). The pouch is bounded by liver, kidney, colon, and duodenum. It is surgically important. The lesser sac opens into it; the gall bladder and duodenum may rupture into it; and fluid travelling from the appendix region upwards lateral to the ascending colon could enter it.

If you run your left index finger along the hepato-renal ligament (lower layer of the coronary ligament) to the left—the finger keeping contact with the liver—it will slip along the **caudate process** of the liver, above the 1st part of the duodenum, and behind the free edge of the lesser omentum, through the **mouth of the lesser sac.** Even though you make allowance for the forward curvature of the vertebral column your finger may catch on the inferior vena cava, which forms the posterior relation of the mouth. Previously the gall bladder was your guide to the mouth of the sac.

Pass now the right index finger through the mouth of the sac and upwards in the median plane between diaphragm and liver. The finger is in the **upper recess of the lesser sac.** This cul-de-sac, which is large enough to admit two fingers, is limited above, as you can verify, at the reflexion of the right layer of the falciform ligament; on the left at the fissure for the ligamentum venosum; and on the right at the inferior vena cava, which occupies the left part of the bare area of the liver. On the right therefore the reflexion constitutes the 3rd or left side of the coronary ligament. The corona limiting the bare area (that is the area devoid of peritoneum) is therefore not circular but triangular. The area of liver lined by this cul-de-sac is the **caudate lobe,** or lobe with the tail; the tail or caudate process being the narrow isthmus of liver bounding the mouth of the sac above.

Examine the peritoneal attachments of the spleen. Stand on the right side of the body and, passing your right hand

above the phrenico-colic ligament, let the backs of your fingers follow the diaphragm until the spleen lies scooped in your palm. Adhesions that can be broken down with the fingers sometimes cause the spleen to adhere loosely to the diaphragm. Verify that your finger tips pass from the diaphragm across the anterior surface of the left kidney where they are arrested by the **lieno-renal ligament,** i.e., the peritoneal connexion between spleen and kidney. Another peritoneal ligament passes from the spleen to the greater curvature of the stomach: this, the **gastro-splenic omentum,** has already been identified as the left portion of the greater omentum. The two ligaments, lieno-renal and gastro-splenic, suspend the spleen between the kidney and the stomach and form a pedicle for it in which vessels run.

By the following procedure you can conveniently investigate the **pedicle of the spleen** and the lesser sac of peritoneum at the same time: While still standing on the right side of the body, run your right middle finger upwards between the kidney and the spleen, and your right index finger upwards between the stomach and the spleen. The "pedicle or stalk" of the spleen now lies in the cleft between these two fingers as though in a clamp. The pedicle has a free lower border (and a free upper border) or you could not grasp it as you are doing. Its linear site of attachment to the spleen is around the **hilum.** Clamped between your index and middle fingers are four layers of peritoneum. Of this you can satisfy yourself by passing your left index finger through the mouth of the lesser sac and across the abdomen, behind the stomach, till it touches the spleen between your two right fingers which are clamping the "pedicle." If your left index will not reach all the way, pass it as far as it will go, tear through the lesser omentum over its tip, withdraw the finger, and re-insert it at the half-way opening just made. The hilum of the spleen,

which you are palpating, is situated at the left extremity of the lesser sac. To explore the lower limit of the sac, pass your left index through its mouth and downwards behind the stomach and anterior two layers of greater omentum and in front of the pancreas, transverse mesocolon, transverse colon, and posterior two layers of the greater omentum. If the lower limits of the sac are shut off from the main portion, they can be investigated after snipping through the anterior two layers of the greater omentum below the stomach. The upper limits of the lesser sac you have already noted in your investigation of the peritoneal attachments of the liver.

Observe that as a result of the projection from the posterior abdominal wall of the mesentery, the ascending colon and the descending colon, four gutters exist. The right lateral gutter lies to the right of the ascending colon and would conduct fluid from the lesser sac via the hepato-renal pouch into the pelvis; the left lateral gutter, to the left of the descending colon, is closed above by the phrenico-colic ligament; the gutter to the right of the mesentery is closed above and below; the gutter to the left of the mesentery leads, like the two lateral gutters, to the pelvis.

Certain peritoneal folds or ligaments have already been noted. Find now the following **fossae** and the **peritoneal folds** guarding them:

1. **Superior duodenal, inferior duodenal, paraduodenal and retroduodenal fossae.** Their mouths face each other and open to the left of the duodenal-jejunal junction. One or more is commonly present and the folds guarding the superior and paraduodenal fossae usually contain the inferior mesenteric vein.
2. **Superior ileo-cecal, inferior ileo-cecal and retro-cecal fossae.** The superior is produced by a fold running from the upper aspect of the end of the ileum to the be-

ginning of the ascending colon; it contains the anterior cecal artery. The inferior is produced by a fold running from the lower aspect of the end of the ileum to the mesentery of the appendix; it is bloodless. The retro-cecal, if extensive is also retro-colic.

3. **Recess of pelvic mesocolon or intersigmoid fossa,** opens at the apex of the inverted V-shaped mesentery of the pelvic mesocolon. It will admit the tip of a little finger and occasionally extends upwards for 3–4 inches.

Read now an account of the peritoneum, its development and morphology.

The Lesser Omentum, the Bile Ducts, the Celiac Artery, the Portal Vein. Sponge the abdominal contents with soap and water (but do not wash them), in order to cleanse and freshen them. Then begin dissection. You will remove peritoneum as dissection proceeds, for, of course, by now you appreciate that all the abdominal contents are either enveloped in peritoneum or covered with it.

Insert a finger in the mouth of the lesser sac and identify by touch and sight the structures—covered, of course, with peritoneum—forming its boundary. Above, is the tail of the caudate lobe of the liver; below, is the first part of the duodenum; in front, is the portal vein (with the bile duct and hepatic artery); behind, is the inferior vena cava. Replace the finger by a roll of paper, thick stick or other suitable instrument. Remove the peritoneum from the free edge until you meet the **bile duct.** It is the most lateral structure. Clean it from below upwards, being careful not to injure, (a) the cystic duct which joins it on its right side, (b) the hepatic artery which lies to its left, and (c) the cystic artery (to the gall bladder) which sometimes crosses the bile passages. The

bile duct is about the same caliber as the handle of your seeker. Trace the **cystic duct** to the gall bladder and the **common hepatic duct** to the porta of the liver where it is formed by the union of the **right and left hepatic ducts.** Consult your text-book for variations in the ducts.

Pick up the **hepatic artery** which lies in contact with the left side of the bile duct. The following three branches are to be found and cleaned as you trace the hepatic artery upwards to its bifurcation near or in the porta of the liver, and downwards to its origin from the celiac axis. Many nerve fibers and lymph vessels will be met, but cannot be saved:

1. **Cystic artery,** a delicate branch found usually near the cystic duct. It commonly arises from the right terminal branch but may spring from the main vessel. If you have trouble with it look for its inferior branch on the free surface of the gall bladder, after stripping the peritoneum from the left side of the neck of the gall bladder, and trace it to its source.
2. **Right gastric artery,** a slender branch arising from the left side of the hepatic a variable distance above the first part of the duodenum and descending to the lesser curvature of the stomach.
3. **Gastro-duodenal artery,** a large branch springing from the hepatic where that vessel turns up to enter the free edge of the lesser omentum. It is lower than 1 and 2 and at once descends and disappears between the first part of the duodenum and the pancreas.

Follow the main stem of the hepatic artery to the left along the upper border of the pancreas. Here it lies in a fold of peritoneum—not easily identified in the cadaver—known as the **right gastro-pancreatic fold.** Try to locate the origin of the vessel from the short stem of the **celiac artery** in the mid-

plane. If this procedure is difficult follow the vessel as far as you can and leave it. You will see its origin more readily on a future occasion.

Consult your text-book for the possible variations of the hepatic artery you may meet, and note lastly that the liver may receive an additional artery from the superior mesenteric artery—to be seen later—or that the main vessel itself may come from that source. The origins of these variant vessels is not accessible just now.

The **portal vein** is a wide short trunk lying behind the bile duct and hepatic artery, and therefore separated from the roll of paper by but a single layer of peritoneum. Clean it to the porta where it divides into a right and a left branch. Leave these three structures well cleaned, isolated and tidy.

Examine the two curvatures of the **stomach.** Closely applied to the lesser curvature you will see the arterial arch formed by the **right and left gastric arteries;** at some distance from the greater curvature you will see the arch formed by the **right** and **left gastro-epiploic arteries.** At about the midpoint of the greater curvature pick up the gastro-epiploic arch. It lies about a finger's breadth from the greater curvature and can be seen providing (as its name implies) gastric and epiploic (i.e., omental) branches. Clean the arch towards the right by stripping with two pairs of forceps the anterior layer of peritoneum from it; you will be conducted behind the duodenum where you will readily establish the right gastro-epiploic artery as a branch of the gastro-duodenal artery already observed. Now free the omentum from the greater curvature, leaving the gastro-epiploic arteries attached to the stomach by their gastric branches. Cut the stomach across (and the vessels on its curvatures) about its middle and turn it right and left thus opening the lesser sac. Complete the study of the **gastro-**

duodenal artery; note its distance from the pylorus, observe retro-duodenal twigs and follow, if well injected, the **superior pancreatico-duodenal branch.** If not already done, trace the **hepatic artery** to the **celiac artery** which lies in the midline and arises from the aorta. It is not desirable to display completely the origin of the celiac artery from the aorta at this stage, because it is surrounded by a dense and tough nervous network, the **celiac plexus.**

If the subject is not too stout you will be able to trace the tortuous **splenic artery** along the upper border of the pancreas to the spleen noting the **pancreatic branches** to the body of the pancreas and the **short gastric branches** passing via the gastro-splenic ligament to the fundus of the stomach. The splenic artery as it approaches the spleen provides many branches which enter the hilum and then continues as the **left gastro-epiploic artery** already observed. Verify these statements.

If the subject is stout, this procedure for following the splenic artery will be fraught with difficulty. It is then a wise plan to pass the hand round the spleen, to separate it from the left kidney (thus restoring its primitive mesentery) and to bring it right forwards. With it, of course, will come the tail and body of the pancreas. Do not injure this friable organ. Reverse the spleen and clean the now easily accessible splenic artery, and trace the left gastro-epiploic artery to it. Restore the spleen and, if not already done, follow the short gastric branches from the front of the hilum, through the gastro-splenic ligament, to the fundus of the stomach.

With an assistant gripping the lesser curvature of the stomach and holding it tautly forwards, the stem of the **left gastric artery** is readily seen in the free edge of its fold of peritoneum, the **left gastro-pancreatic fold,** which passes

from pancreas to stomach. Clean the artery and identify its **esophageal branch.** On each side of this branch find a vagus nerve entering the abdomen. These are the **anterior and posterior gastric nerves.** Follow them along the lesser curvature and be particular to trace the branch of the posterior gastric nerve along the upper or right border of the stem of the left gastric artery to the **celiac plexus**—the dense, matted, nervous tissue surrounding the celiac axis and to be studied later. In a stout subject this procedure may be a little tedious and sometimes difficult. Therefore, do not be disheartened if you meet with little success, but cease your efforts now, and try again later when the dissection is more advanced.

THE MESENTERIC VESSELS. Throw the transverse colon, with the greater omentum over the chest margin and retain it there. Lifting out any coils that may lie in the pelvic cavity draw the small intestines to the left, in order to render the mesentery tense. At the upper end of the mesentery identify the **duodeno-jejunal junction** and there, using two pairs of blunt forceps, remove the right layer of mesentery in order to expose the stem of the **superior mesenteric artery,** not much smaller than your little finger, descending in front of the third part of the duodenum to enter the root of the mesentery almost in the median plane. It is here sometimes crossed by the upper end of the **inferior mesenteric vein.** To the right of the artery lies the **superior mesenteric vein.** Using two pairs of closed forceps as your dissecting instruments, proceed to clean the artery and vein upwards as far as the lower border of the pancreas. Here the **inferior pancreatico-duodenal artery,** passing upwards and to the right, arises either from the main vessel or from its first jejunal branch; it is seldom seen at this stage and will be dealt with when the pancreas is dissected.

Observe **lymph nodes** along the course of the superior mesenteric artery. Find the stems of the **jejunal and ileal branches** arising from the left side of the artery and the three colic branches from the right side. The **middle colic artery** may be the first branch to arise from the superior mesenteric whilst the **right** and **ileo-colic arteries** often spring from a common stem. It is not necessary to clean every jejunal and ileal branch, but in the upper, middle and lower regions the ultimate pattern of the vessels is to be observed. Clean the colic branches paying particular attention to the ileo-colic artery, whose distribution to the termination of the ileum, the appendix, cecum and ascending colon should be displayed and compared with that illustrated in your text book or atlas.

Turn the small intestines to the right, and find, by inspection and palpation, the bifurcation of the aorta. The origin of the **inferior mesenteric artery** is 1½″ above the bifurcation. Remove the parietal peritoneum at this point, and find and trace the artery and its branches. These are the **super or left colic artery** which ascends, the **inferior left colic artery** commonly as two or three branches which descend, and the **superior rectal artery** which is the continuation of the main stem into the pelvis. Observe the ultimate pattern of supply.

Read an account of the **marginal artery of Drummond** extending from the end of the ileum to the end of the pelvic colon and note the three weak points in this marginal anastomosis: (1) between ileo-colic and right colic; (2) between middle colic and superior left colic; (3) between inferior left colic and superior rectal.

Find the inferior mesenteric vein. It lies at a variable distance to the left of the inferior mesenteric artery and ascends in front of, behind, or between, the branches of that artery. Trace the vein to its termination either in the splenic vein behind the pancreas or (after crossing in front of the root

of the superior mesenteric artery) in the junction of the superior mesenteric and splenic veins.

Removal of Jejunum, Ileum, Cecum, Ascending Colon and Transverse Colon. (In cutting bowel always do so between two strings tied tightly around it to prevent escape of its contents.)

Cut across the jejunum 1″ from the duodeno-jejunal flexure. Cut across the descending colon a little below the left colic flexure. Cut the peritoneum along the lateral edge of the ascending colon and above the right colic flexure. With the fingers behind them, raise the cecum and ascending colon medially, together with their vessels, thus restoring their primitive mesentery. As the colon is turned medially, be careful not to raise the second part of the duodenum with which the colon is in naked contact. Free the transverse colon from the head of the pancreas and, by cutting the mesocolon, free it from the body of the pancreas. Cut the root of the mesentery leaving it about an inch long. Remove all parts thus freed.

Study the interior of 2″ to 3″ sections of **jejunum, ileum** and **colon,** after washing out the contents with running water. Open the **cecum;** see and study the **ileo-colic valve.** Nick the three **teniae coli;** observe the consequent lengthening of the colon and the disappearance of the tucks and pouches for which the teniae are responsible. These pouches are the **haustra** or sacculations.

Blood Vessels of the Pancreas and the Duodenum. Pick off any fat from the surface of the pancreas. Lift up the spleen, and with it the tail of the pancreas, and swing them across to the right side of the abdomen in order to expose the posterior surface of the pancreas. See the **splenic vein** occupying a groove in the pancreas just below the

splenic artery which lies along the upper border. Observe the numerous twigs the artery gives to the gland. Trace the vein to its junction with the superior mesenteric vein, and note once more where the inferior mesenteric vein ends. The resulting large vein, the **portal vein,** is to be followed behind the neck of the pancreas and upwards in front of the inferior vena cava to the liver. Raise the superior mesenteric vessels from the portion of the head of the pancreas they cross. This is the **uncinate process.**

Pick up the **superior pancreatico-duodenal artery**—a branch of the gastro-duodenal—follow the course of its **anterior branch,** and note its supply to the head of the pancreas and to the duodenum. Trace it to its anastomosis with the **inferior pancreatico-duodenal artery**—a branch of the superior mesenteric. This inferior branch is often difficult to find; it may (and often does) come from the uppermost jejunal branch of the superior mesenteric and may pass behind the main artery, in which case it is not visible till this stage of the dissection is reached

Raise the second part of the duodenum and the head of the pancreas from the right kidney and the inferior vena cava, and swing them, as on a hinge, to the left. Note that the space opened up is an areolar one, the duodenum and pancreas being covered posteriorly by a smooth loosely adherent areolar membrane; a similar membrane covers the right kidney and the inferior vena cava. Free and trace the **posterior branch** of the **superior pancreatico-duodenal artery.**

Whilst the duodenum is still turned forwards and to the left, trace the (common) **bile duct** down through an arcade of vessels to its point of entrance into the second part of the duodenum. Notice if there is a lobule of pancreas extending between the terminal portion of the bile duct and the in-

ferior vena cava or if duct and vein are in contact, two areolar membranes alone intervening.

REMOVAL OF SPLEEN, PANCREAS, DUODENUM AND LIVER. Once more turn the spleen, pancreas and splenic vein to the right. Separate the superior mesenteric artery from its vein and cut the vein. Disengage the artery from the pancreas. As you do so, you will require to cut the inferior pancreatico-duodenal artery; cut the inferior mesenteric vein near its termination. Cut the splenic and hepatic arteries near their origins, leaving the left gastric artery intact. Raise the duodenum and pancreas from the posterior body-wall. This procedure renders the duodenum, pancreas and spleen a mobile mass, which can be turned from side to side as occasion demands, and allows their posterior relations to be studied. Before proceeding further, review the peritoneal attachments of the liver so that you will be able to follow intelligently the steps taken for its removal.

The peritoneal attachments of the liver are to be cut one by one and a segment of the inferior vena cava is to be removed with that organ. Proceed as follows: Cut the **round** and **falciform ligaments** of the liver and, sweeping the knife to the left, cut the **left triangular ligament.** Be careful not to wound the diaphragm. Cut across the peritoneum covering the inferior vena cava at the mouth of the lesser sac. Here the peritoneum is reflected from liver to inferior vena cava; just to the right it is reflected from liver to adrenal gland, and still more to the right from liver to right kidney. This reflexion is the **lower layer of the coronary ligament.** Hold the liver well up and cut along this line of reflexion. Here also cut the **inferior vena cava,** after first freeing it behind with the rounded handle of the knife. Pulling the liver down from the diaphragm forcibly with the left hand, cut the **inferior**

vena cava once again where it pierces the diaphragm. It now remains to cut the upper and left layers of the coronary ligament. With the left hand passed upwards and to the right behind the caudate lobe, pull the liver forwards and to the right. This renders prominent the **left layer of the coronary ligament,** i.e., the right margin of the upper recess of the lesser sac. Cut along it, and with the fingers separate the loose tissue between the inferior vena cava and the right adrenal gland. Pull the liver downwards and to the left, see and cut the **upper layer of the coronary ligament,** and snip through the **right triangular ligament.** Lift out "*en masse*" the liver, spleen, right half of the stomach, duodenum and pancreas with their associated vessels and ducts, and put them aside for study later.

THE THREE PAIRED GLANDS. Identify and clean now, so that they will not be injured or destroyed, the **testicular (ovarian) arteries** and **veins** from the deep inguinal rings upwards to their sources (or terminations).

Read an account of the **renal fascia.** There is, as a rule, little, if any, fat in front of the kidney. Further, while most of the fat lies behind and outside the renal fascia (paranephric fat), there is a variable amount behind and inside the fascia (perinephric fat). Incise the renal fascia vertically over the surface of the kidney and, working inside the fascia, with fingers and knife-handle, free the kidney all round from the perinephric fat. While freeing the upper pole be careful to keep close to the kidney in order not to injure the adrenal gland which is separated from it only by a layer of fat. Raise the kidney and swing it medially, observing that the renal fascia is an areolar cul-de-sac, closed above and laterally but open below. Medially the fascial wall of the sac passes to the inferior vena cava or aorta, according to the side. Demon-

strate these facts and note that the anterior layer of the sac is carried by the renal veins in front of the inferior vena cava to the opposite kidney. Clean the perinephric fat away from the kidney, again being careful of the adrenal gland at the upper pole. Clean the **renal vessels.** Clean the **ureter** down to the pelvic brim. On the left, where the descending colon is intact, you should observe once more the relative positions of the following structures to one another:—left colic arteries, inferior mesenteric vein, testicular vessels and ureter.

CELIAC PLEXUS, CELIAC GANGLION AND ADRENAL GLAND. The dense, matted tissue around the celiac artery is the **celiac plexus.** On each side of the artery is the irregularly nodular, tough **celiac ganglion.** This occupies the inch interval between the celiac artery and the adrenal gland. Clean the ganglion and preserve its delicate branches to the adrenal gland. Lift up the fatty mass that surmounts the upper pole of the kidney and, holding it in one hand, clean the free lateral crescentic border of the **adrenal gland** by removing the fat piecemeal. The gland is very friable and, if the considerable amount of fat round it is pulled away with forceps, it will tear, so proceed cautiously as you clean the whole gland. Identify its blood supply. One vessel comes from the **inferior phrenic artery** which ascends on the diaphragm and should be preserved; a second comes from the renal artery; a third from the aorta itself.

To find the **greater splanchnic nerve,** turn the gland and ganglion medially. You will then see the stout nerve piercing the crus of the diaphragm abreast of the celiac artery and about 1″ from it. It descends for an inch to join the celiac ganglion.

Lastly, if you were not previously successful in tracing the

anterior and the **posterior gastric nerves** (two vagus nerves) and did not find the branch of the posterior nerve to the celiac ganglion, find them now, following the instructions previously given on page 98. Now that the three paired glands are cleaned, replace the liver and the other organs lifted out with it. When restored to their proper positions the two halves of the stomach must fit; further, the pancreas must so lie that the superior mesenteric artery crosses the uncinate process and occupies a position immediately to the left of its vein. Observe now the extent to which the liver lies in front of the right kidney and the position of the right adrenal gland. Only when you have satisfied yourself as to the relative positions all these organs bear to one another should you once more remove the parts.

At this time also remove the **left kidney;** divide it into anterior and posterior halves by splitting it along its convex border, then study it and read an account of its structure.

Study the **left adrenal gland.** Leave the right kidney in place.

THE LIVER. Turn to the organs of the gastro-intestinal tract removed. Free the cut edge of the peritoneum (i.e., the three layers of the coronary ligament) encircling the bare area of the liver and verify its lines of reflexion. Dissect the porta noting the arrangements of ducts, arteries and veins within it. Note that the portal vein is separated from the inferior vena cava by the tail (cauda) of the caudate lobe and that this is the upper limit of the mouth of the lesser sac. Section the liver and note the adherence of its capsule. Observe the branches of the portal vein, bile duct and hepatic artery lying together at the periphery of a lobule and the solitary hepatic vein lying in the center. Look into the inferior vena cava

from above (after freeing it of blood clots) and see the **valveless hepatic veins** that enter it and point towards the heart. Read an account of the liver.

THE DUODENUM AND PANCREAS. Read an account of the duodenum. It is a profitable procedure to inject the duodenum with melted wax after tying it off on the gastric side of the pylorus. At the same time, if the gall bladder is injected with wax, an excellent cast may be obtained of the duodenum, gall bladder and bile passages. After the wax has hardened, the duodenum may be slit lengthwise and the cast of its interior studied. Look particularly for **diverticula** of the duodenum and **accessory hepatic ducts.** Dissect the **pancreatic ducts,** working from the bile duct, and examine their dispositions. Read an account of the duodenum and of the pancreas.

THE GREAT VESSELS OF THE ABDOMEN. Clean the aorta, the inferior vena cava, and their branches. As this is being done, preserve the **intermesenteric** and **hypogastric plexuses** and read an account of them. They are fine networks of nerve fibres and they lie in front of the aorta and in front of the left common iliac vein. Offshoots follow the branches of the aorta as subsidiary plexuses named after them. Lying immediately in front of the anterior border of the Psoas—the muscle attached to the sides of the bodies of the lumbar vertebrae and their discs—is the **sympathetic trunk.** Its medial branches, the **lumbar splanchnic nerves,** run forwards to contribute to the two prevertebral plexuses mentioned above; those on the right appear between the inferior vena cava and the aorta. Its lateral branches, **rami communicantes,** run laterally and backwards, hugging the vertebrae with, or near, the **lumbar arteries.** You can clean the plexus either by commencing with the network on the aorta or by dealing first with the sympathetic trunk.

THE POSTERIOR WALL OF THE ABDOMEN PROPER. The muscles of the posterior wall, shining through their fasciae, must be identified but not disturbed:

1. **Psoas,** already identified as clinging to the sides of the lumbar vertebrae and their discs.
2. **Iliacus,** in contact with the lower portion of the lateral border of the Psoas, and occupying the extensive iliac fossa of the false pelvis.
3. **Quadratus Lumborum,** in contact with the upper portion of the lateral border of the Psoas and running upwards and medialwards from the iliac crest to the medial half of the twelfth rib.
4. **Transversus Abdominis,** running horizontally lateralwards from behind the lateral border of the Quadratus Lumborum.

The vertebral origin of the **Diaphragm** will be investigated in a moment. For the purpose of identifying the nerves of the posterior abdominal wall it is sufficient to recognize the above four muscles. Read an account of them and of the **fascia iliaca.**

The branches of the **lumbar plexus** all pierce the Psoas muscle. Identify them in the following order:

1. **Subcostal nerve,** half an inch below the last rib and coming from under cover of the **lateral arcuate ligament**—the fibrous arch spanning the origin of the Quadratus Lumborum.
2. **Ilio-hypogastric** and **Ilio-inguinal nerves,** arising by a common stem and crossing the Quadratus Lumborum below the subcostal nerve. The ilio-hypogastric is the higher and pierces the aponeurosis of the Transversus a short distance above the iliac crest; the ilio-inguinal usually runs along the medial lip of the iliac crest.
3. **Genito-femoral nerve,** piercing the anterior surface of the Psoas and its fascia as one or two branches.

4. **Lateral femoral cutaneous nerve,** crossing the Iliacus and running towards the anterior superior iliac spine. It passes behind the inguinal ligament usually near the spine.
5. **Femoral nerve,** a large nerve lying in the angle between Psoas and Iliacus. It passes behind the inguinal ligament near its mid-point.
6. **Obturator nerve,** issuing from the medial border of the Psoas and found by separating that border from the common iliac vessels. It lies anterior to the ala of the sacrum and is directed to the obturator foramen.
7. Branch of the 4th lumbar nerve joining the 5th to form the **lumbo-sacral trunk,** which trunk lies below the obturator nerve and crosses the ala of the sacrum to join the **sacral plexus** in the pelvis.

Look for communications between the genito-femoral, the lateral femoral cutaneous and the ilio-inguinal nerves. Cut the **Psoas** two inches above the inguinal ligament and, by blunt dissection, peel it up and gradually remove it, in order to expose the nerves more fully. Study the plexus.

It is a good plan now to review the posterior relations of the right kidney. Study the attachments of the **Quadratus Lumborum;** then remove it, in order to study the vertebral attachment of the **Transversus.** Look for an *Intertransverse* muscle stretching between the adjacent borders of two transverse processes. Trace the **rami communicantes** and a **lumbar artery** and **vein** deep to the fascia which bridges the side of a vertebral body and from which the Psoas arises. Remove one of these fascial bridges and trace a lumbar artery in continuity.

The Diaphragm. Beginning at the periphery, strip the peritoneum and areolar tissue off the muscle fibers of the

Diaphragm for 2 or 3 inches. Remove the costal origin of the Transversus and see the slips of origin of the Diaphragm from the costal cartilages. Observe the triangular gap between the costal and vertebral origins; this, the **vertebro-costal triangle,** is usually more obvious on the left side. Observe the **lateral** and **medial arcuate ligaments,** the fascial thickenings from which the Diaphragm in part arises and which arch over the Quadratus Lumborum and Psoas respectively. Beneath the lateral ligament issues the **subcostal nerve;** beneath the medial, the **sympathetic trunk.** The **median arcuate ligament** can readily be found since it arches over the celiac artery. It is a fibrous arch and will lead you to the medial fibrous borders of the two **crura**—the attachment of the Diaphragm to the bodies of the lumbar vertebrae. Clean the crura: the **greater splanchnic nerves** have been seen piercing them. Find the **lesser splanchnic nerves** which also pierce the crura. Clean the **caval, esophageal** and **aortic orifices,** noting the structures that pass through them.

Intervertebral Joint. Read an account of the intervertebral joints.

Clean the **anterior longitudinal ligament,** define its borders and note its thickness and attachments. Cut through the **intervertebral disc** between the bodies of the 4th and 5th lumbar vertebrae. Do this with a long sharp sweep of the knife, in order to leave clean for inspection the **annulus fibrosus.** Scoop out the **nucleus pulposus** and count the number of concentric layers of fibers in the annulus fibrosus.

On the left side the descending colon and its vessels (gastro-intestinal tract), and the testicular vessels and ureter (genito-urinary tract) are in situ, in order that you may appreciate the respective planes they occupy. Being

now no longer required, they must be suitably dealt with in severing the body.

REMOVAL OF THE PELVIS AND LOWER LIMBS. At the level at which you have separated the vertebral bodies sever everything in your path—posterior body-wall muscles, ureters, inferior vena cava and aorta. The lower limbs must now be allowed to hang supported over the end of the table, but lower them gently so that the articular processes between the fourth and fifth lumbar vertebrae disengage. Cut through the deep muscles of the back. (This procedure is not to be undertaken until the dissectors of the head and neck have removed the spinal cord.)

THE PERINEUM

The perineum is usually dissected with the subject in the lithotomy position, i.e., on the back with the hips and knees flexed and the limbs widely separated. Since the body is now divided, this is not feasible; moreover, the joints are difficult to flex satisfactorily in the cadaver. Therefore, the subject must be inverted and fixed by a bandage to the *slanting* side of the frame provided. Protect the skin from injury by the bandage and see that the two limbs are well separated and so retained. The dissector should sit on a high stool. It is of the utmost importance that the subject be put in a proper posture or a good dissection will be impossible. Therefore, the few moments spent in obtaining the desired position are not wasted.

Before beginning dissection procure an articulated pelvis, preferably with the ligaments intact. Invert it and inspect the region of the **pelvic outlet.** Identify:

1. **Sacral tuberosities,** bounding the outlet laterally.

2. **Ischio-pubic rami,** running upwards and medially to meet in the pubic symphysis. Notice the everted lips, in the male, for the attachment of the external genitalia. The interval between the pubic rami immediately below the symphysis is filled by the stout triangular **perineal membrane.**
3. **Ischial spines,** lying $1\frac{1}{2}''$ above the ischial tuberosities.
4. **Sacro-tuberous ligaments,** passing from the ischial tuberosities to the sides of the sacrum and coccyx.
5. **Sacro-spinous ligaments,** passing from the ischial spines to the sides of the sacrum and coccyx.
6. **Lesser sacro-sciatic foramen,** between the ligaments. This foramen is the entrance to the perineum for vessels and nerves from the gluteal region.
7. **Coccyx,** in the midline posteriorly.

THE MALE PERINEUM

The region under consideration is diamond-shaped and is divided into a posterior part—the **anal triangle** and an anterior part—the **urogenital triangle.**

THE ANAL TRIANGLE. Make a midline incision that splits the scrotum, restoring it to its developmental right and left halves. Carry the cut backwards, encircling the anus, to a point beyond the tip of the coccyx and forwards below the penis. Make a transverse incision about $\frac{1}{2}''$ in front of the anus and carry it laterally across the ischial tuberosities. Do no dissection lateral to a sagittal plane through the palpable ischial tuberosity, because this region belongs to the dissectors of the lower limb. There is much fat in the anal triangle, therefore, the two posterior triangular skin-flaps may be reflected speedily. When that has been done, make a 2″ long sagittal cut through the fat covering the Gluteus Maximus until the plane of the fleshy fibers of that

muscle is reached. Clean the medial part of the lower border of the muscle but avoid injury to the nerves that turn round it.

These are: (a) a twig of the **4th sacral nerve** found close to the coccyx on the median areolar partition that runs backwards from the anus; (b) **perforating cutaneous nerve,** derived from the 2nd and 3rd sacral nerves and found near the medial side of the ischial tuberosity; (c) twigs from the **posterior cutaneous nerve of the thigh** (S.2 and 3) found lateral to the ischial tuberosity. Do not look for (c) now since it more properly belongs to the dissector of the lower limb, and do not waste time over the other two small nerves.

Now choose a point on a line between the ischial tuberosity and the coccyx, but somewhat nearer the former, and plunge the knife, with the edge of the blade directed towards the anus, for a full inch into the fat of the **ischio-rectal fossa**—the space beside the anal canal lined with fascia and filled with fat. Cut through the fat and, as the anus is approached, gradually withdraw the knife. Insert the finger far into the cut and feel the **inferior rectal (haemorrhoidal) vessels** and **nerve** as strings crossing in the fat. Enlarge the opening with the finger; look in the space; see, and then clean these vessels and nerve. Having found the vessels and nerve, rapidly remove all the fat by picking it out or wiping it away, and explore the fossa. A generous supply of cotton waste will be of great service to you.

Clean the **Sphincter Ani Externus** which is more than an inch in depth and which blends above with the Levator Ani. Preserve the branches of the inferior rectal (haemorrhoidal) vessels and nerve that enter it. Identify the median areolar partition running backwards from the anus.

You are working with the part inverted; therefore, to get your landmarks, feel, deep to the border of the Gluteus Maximus, the **sacro-tuberous ligament.** Clean this until its

edge is exposed, and observe that the strong fascia covering the **Obturator Internus** (which is the muscle clothing the lateral wall of the space) is attached to this edge. Press backwards and laterally above the ischial tuberosity and feel the **spine of the ischium.** Work with an inverted bony pelvis beside you and refer to it often. If this is not available, at least have a hip bone beside you.

Identify now the **pudendal (Alcock's) canal.** It runs horizontally forwards, in the fascia of the Obturator Internus, on the lateral wall of the fossa $1\frac{1}{2}''$ above the ischial tuberosity. The (internal) **pudendal nerve** and **vessels** enter the canal by turning round the ischial spine, so the spine is your guide. If you follow back the inferior haemorrhoidal nerve and vessels they also will lead you to the pudendal canal. Slit the Obturator Internus fascia antero-posteriorly and so open the canal. In it the **perineal nerve** is below, the **dorsal nerve of the penis** is above, and the **internal pudendal vessels** are between.

The **Levator Ani** is the thin muscle which roofs the ischiorectal fossa and which descends obliquely medially from the side wall of the pelvis, just above the pudendal canal, to blend with the wall of the anal canal. Clean it, noting its direction and that the fascia covering it is thin. You must not, in any circumstances, invade the urogenital region in front.

If the muscles are well hardened, but not otherwise, and if your knife is as sharp as a razor, cut across the Sphincter Ani Externus into the areolar sheet deep to it, and turn the cut ends forwards and backwards. Cut across the Levator Ani where it blends with the muscle wall of the anal canal, and turn aside also the longitudinal muscle of that wall (representing the same layer as the teniae coli). You now see the **Sphincter Ani Internus** (representing the circular coat of the intestine) whose lower border is free and thick. Notice that its lower border is higher than the lower border of the Sphincter Ani Externus.

THE UROGENITAL TRIANGLE. Reverse the wooden frame and tie the parts to the *perpendicular* side of this frame. In the urogenital triangle there is very little fat, therefore reflect the skin flaps carefully. The **superficial fascia** is laminated and its deeper layer, the **superficial perineal fascia** (Colles' fascia), is continuous with Scarpa's fascia. Note that Colles' fascia is attached laterally to the sides of the pubic arch; posteriorly it blends with the **perineal membrane** at the base of the triangle. Far back, lying deep to the fat and curving forwards lateral to the ischial tuberosity to reach the scrotum, is the *perineal branch of the posterior cutaneous nerve of the thigh.* It is wide of the triangle at first; it is difficult to find; and it is not of sufficient importance to delay you long. Make a longitudinal incision through Colles' fascia about 1″ from the median plane, and with the seeker, pick up the **posterior scrotal nerves** and **artery** and follow them back to the base of the triangle.

By examination with the finger-tip inserted deep to the fascia, demonstrate the posterior limit (base) of the **superficial perineal pouch**, i.e., satisfy yourself that the pouch is closed posteriorly and that you cannot go backwards in it beyond the triangle. By way of confirmation pull the **perineal body** (central point of the perineum) to one side and, with a finger in the opposite ischio-rectal fossa, press forwards and locate the base of the **perineal membrane** thus rendered taut. Trace the **posterior scrotal nerves** backwards beyond the limits of the pouch, and establish their identity as far back as their source from the perineal nerve. Pick up the **perineal nerve**; see, and carefully preserve, its motor branch to the muscles of the urogenital triangle. Observe at the base of the triangle the *transverse perineal artery* running transversely to anastomose with its fellow of the opposite side.

Identify, clean, and separate from one another, the three paired superficial perineal muscles:

1. **Transversus Perinei Superficialis,** a slender muscle passing in the base of the superficial perineal pouch from the ischial tuberosity to the **perineal body** or **central point of the perineum,** a midline origin for perineal muscles.
2. **Ischio-cavernosus,** arising from the ischial tuberosity and applied to the side of the ischio-pubic ramus where it covers the **crus** and **corpus cavernosum penis.**
3. **Bulbo-spongiosus,** a thin flat sheet of muscle arising with its fellow from the perineal body and median raphe in front of it, and covering the **bulbus penis** and **corpus spongiosum penis.** It is inserted into: (a) perineal membrane; further forward into (b) dorsum of corpus spongiosum; still further forward into (c) fascia of the dorsum of the penis. It therefore envelops first one, finally all three erectile bodies. Endeavour to verify this.

Split the Bulbo-spongiosus in the midline and remove it from one side, thereby exposing the **bulb of the penis**—the swollen posterior extremity of the midline cylinder of erectile tissue, the **corpus spongiosum penis.** Observe the attachment of the bulb to the perineal membrane. Clear away the Ischio-cavernosus on the same side, thereby exposing the **crus penis**—the pointed fibrous attachment of the lateral cylinder of erectile tissue, the **corpus cavernosum penis.** The **perineal membrane** is now fully exposed; examine it.

When the abdominal wall was dissected the **suspensory ligament of the penis** was left in place. Notice that it forms a sling or loop for the penis at the point where the latter makes a sharp bend. Separate the suspensory ligament from the front of the symphysis pubis, thereby freeing

the penis, which may then be pulled down until the lower limit of the symphysis is reached. At this point see the **deep dorsal vein of the penis** passing into the pelvis beneath the pubic arch.

Remove the skin from the penis. The superficial fascia of the penis is laminated and devoid of fat; in it may be seen and traced the **superficial dorsal vein of the penis.** Deep to this fascia the penis possesses a tubular investing sheath, the **fascia penis,** which is closed in front at the corona. Deep to the fascia penis again are the **deep dorsal vein, dorsal artery** and **dorsal nerve.**

At the point where the deep dorsal vein was seen passing beneath the pubic arch, the dorsal artery and nerve are readily picked up passing obliquely along the side of the penis. Trace the nerve back to its origin as one of the terminal branches of the internal pudendal nerve, thus establishing its course and continuity. With the aid of a knife separate the **corpus spongiosum** from the median groove between the fused corpora cavernosa, and detach the **crus** on one side. Make two cross-sections of the penis, one about one inch in front of the **bulb** and the other through the **glans.** Observe the form and outline of the **urethra** in each region.

Study, and read an account of, the structure of the penis.

Insert the handle of the seeker into the vesical end of the divided urethra and, without using force, cause it to enter the bladder. Remove the perineal membrane and so open the **deep perineal pouch.** In the pouch: (a) about a third of an inch in front of the base of the perineal membrane, look for a large branch of the internal pudendal, the **artery to the bulb;** (b) try to define a sheet of muscle, the *Transversus Perinei Profundus*, stretching from one side of the pubic arch to the other; (c) separate, from around the urethra, those fibers of the deep muscle, the *Sphincter Urethrae*, that encircle the urethra, and (d) thereby reach the thin-

walled **membranous urethra**; lastly (e) look under cover of the deep transverse muscle for two glands, the **bulbo-urethral glands,** one on each side of the urethra—each is smaller than a split pea.

Now carry out the following procedure to expose the prostate from the perineum:

First, make the separation of the anal and urogenital triangles complete by detaching the Sphincter Ani Externus from the perineal body or central point of the perineum. Next, pull the anal canal and rectum backwards and define the anterior (medial), free borders of the Levatores Ani. In doing so, work with the point of the knife very strictly in the median plane because the borders are but a third of an inch apart. Then, keeping in mind the direction of the anal canal, insert the handle of the knife between the borders of the Levatores Ani, and ease the canal backwards. Areolar tissue and involuntary muscle (Recto-urethralis), joining the rectum to the base of the perineal membrane, require to be snipped through. Lastly, proceed with the knife-handle to push the structures developed from (and associated with) the anterior or urogenital part of the cloaca from the posterior or rectal part, and so expose the tough fascia covering the posterior surface of the prostate. You have, by the foregoing procedure, demonstrated that the back of the prostate and the front of the rectum can be exposed from the skin surface bloodlessly and without cutting a nerve, owing to the fact that the anal and the urogenital triangles are supplied by separate branches of the internal pudendal artery and nerve.

THE FEMALE PERINEUM

The advice and instructions given with regard to posture are as applicable to the female perineum as to the male. Examine first the female external genitalia. These are:

mons pubis, labia majora et minora, vaginal orifice, glans clitoridis and **prepuce.**

Make a midline incision from behind the coccyx forwards to the pubis, skirting the anus and labia majora. Make a transverse skin incision that crosses the midline between anal and vaginal orifices and carry it laterally as far as the ischial tuberosities. Reflect the two posterior skin flaps, but do no dissection lateral to the sagittal plane in which the ischial tuberosity lies, because it belongs to the lower limb.

THE ANAL TRIANGLE is to be dissected exactly as in the male, following the directions on pages 111 to 113 but substituting the adjective "labial" for "scrotal".

THE UROGENITAL TRIANGLE. This dissection is rather more difficult in the female than in the male. Therefore the student should dissect, or at least see, the urogenital triangle in the male before undertaking the dissection in the female.

Reflect the two anterior flaps laterally and raise medially the skin covering the labium majus from the considerable quantity of underlying fat which contains several large **labial veins,** and into which you should follow a fibrous cord, the **round ligament of the uterus.** Perhaps, by palpating within the ischio-rectal fossa, you can feel the base of the perineal membrane stretching from the perineal body to the ischial tuberosity. The **perineal body** is a fibro-muscular mass between the anus and the vagina. Lateral to the labium majus make a longitudinal cut through the thin superficial perineal fascia (Colles' fascia) into the superficial perineal pouch. Insert the finger-tip and try to find the base of the pouch.

Clean the **posterior labial nerves** and **vessels** running

forwards. They can be identified by pulling or following forwards the internal pudendal nerve and vessels in the pudendal canal. Find the *transverse perineal artery* running in the base of the pouch and look for the *perineal branch of the posterior cutaneous nerve of the thigh.* This nerve lies deep to the fat and curves forward lateral to the ischial tuberosity. At first it is wide of the triangle. It is difficult to find and not sufficiently important to delay you.

Clean the three superficial perineal muscles. They correspond to those already dissected, or at least seen, in the male: they are however smaller and more difficult to make out. The **Transversus Perinei Superficialis,** in the base of the superficial perineal pouch, is very slender; the **Ischio-cavernosus** covering the crus clitoridis is a thin sheet; the **Bulbo-spongiosus** (Sphincter Vaginae) is a broad, but thin, sheet surrounding the vaginal orifice and covering the bulb of the vestibule. It too is, of course, bilateral.

Between these three muscles at the base of the superficial perineal pouch, a triangular area of the perineal membrane is readily exposed. As in the male, the Ischio-cavernosus and the Bulbo-spongiosus cover erectile tissue. The former covers the **crus** and **corpus cavernosum clitoridis,** the latter the **bulb of the vestibule.** Remove the muscles and thereby expose these erectile bodies.

Working on its lateral side, trace the crus of the clitoris and clean it, noting the **suspensory ligament of the clitoris** which forms for it a sling, as in the case of the penis. On raising and freeing the hinder end of the bulb of the vestibule the **greater vestibular gland** may be seen. The perineal membrane is delicate and difficult to preserve; probably it has been torn, thus opening into the **deep perineal pouch** in which the *Transversus Perinei Profundus* and *Sphincter Urethrae* muscles lie. Trace forwards the motor branch of

the **perineal nerve** into the more medial part of this pouch. At the lateral border of the free end of the crus find the **dorsal nerve** and **artery of the clitoris** and trace them on to the dorsum of the clitoris. Trace medially the **artery to the bulb** of the vestibule.

THE PELVIS

Refer once more to the articulated pelvis and note the following features relative to the true pelvis:

1. The cavity of the true pelvis is continuous with that of the abdomen at the **pelvic brim.** This pelvic brim, also known as the **pelvic inlet,** consists of a pair of curved **arcuate lines,** each of which may be recognized as made up of three parts. Behind is the **sacral part,** comprised by the **promontory** and the lower edge of the **ala of the sacrum;** the intermediate or **iliac part** is the lower half of the medial border of the ilium which, at the bony **ilio-pectineal eminence,** is continuous with the anterior or **pubic part** made up of the **pectineal line**, **pubic crest** and upper end of the **pubic symphysis.**

2. When oriented in the erect posture the pelvic inlet is inclined to the horizontal at about an angle of 60°, the top of the symphysis pubis being about on the same horizontal plane as the tip of the coccyx.

3. The bony walls present certain deficiencies: an **obturator foramen,** closed by membrane and covered by muscle (**Obturator Internus**), is readily recognizable since it is completely ringed with bone; behind this, the wide interval existing between sacrum and coccyx postero-medially and hip bone antero-laterally, has been seen to be converted into two foramina by the presence of two ligaments, both passing from the side of the lower part of the sacrum and the coccyx, the one to the ischial spine—**sacro-spinous ligament,** the other to the ischial tuberosity—**sacro-tuberous ligament.** The re-

sulting two foramina are: (1) the **greater sciatic foramen** above the ligaments; (2) the **lesser sciatic foramen** between the ligaments. The greater gives egress from the pelvis, the lesser gives ingress to the perineum.

4. A funnel-shaped muscular diaphragm, the paired **Levatores Ani,** acts as a floor for the pelvic contents. Each Levator Ani is attached along a semi-circular line from the side of the sacrum via the front of the sacro-spinous ligament to the ischial spine; thence via a tendinous arch spanning the Obturator Internus to the back of the body of the pubis. The two Levatores Ani just fail to meet on the pubis, hence each has a medial free border anteriorly; posteriorly they meet or blend with the walls of the structures that pass between them in the midline. An understanding of the disposition of this diaphragm will be of great help to the student in his dissection of the pelvic contents.

The pelvic cavity resembles a basin whose bony walls are in part lined with muscles and whose floor or diaphragm is also muscular. The muscles, in turn, are lined with fascia—the **parietal layer of the pelvic fascia**—and the principal organs contained in the cavity find their outlet in the midline, through the floor where they are anchored. As these organs are highly distensible, spaces are provided on their sides for their expansion, and these extra-peritoneal spaces are loosely filled with (laminated) fatty fascia. In one important layer of this fascia, the **recto-vesical layer** which stretches across the pelvis from side to side as a vertical sheet, vessels succeed in reaching the midline organs from the larger vessels lying on the side pelvic wall. The loose fascia investing the organs is the **visceral layer of the pelvic fascia.**

Above, the fascia is lined on its superior surface with peritoneum continuous with that of the abdominal cavity, so that especially the upper surfaces of the organs receive an invest-

ment from the peritoneum. The degree to which peritoneum passes down the front, back and sides of the organs will determine the depth of the resulting peritoneal fossae. Or, expressed in other words, the organs, invaginating the peritoneum from below, secure for themselves partial investment and at the same time produce a series of peritoneal fossae between adjacent organs and between an organ and the pelvic wall.

In the pelvis the gastro-intestinal system lies posteriorly, the genital system is intermediate and the urinary system is in front; this is the reverse of the state of affairs obtaining in the abdomen.

THE MALE PELVIS

Examine the peritoneum. It passes from the back of the anterior abdominal wall and the back of the pubis on to the superior surface of the empty **urinary bladder**; as the bladder fills the peritoneum is stripped off pubis and abdominal wall leaving them bare for a variable distance. On either side of the bladder a **paravesical peritoneal fossa** is apparent, particularly obvious when the bladder is full. The peritoneum next passes for half an inch down the posterior surface of the bladder to cap the **seminal vesicles**—two small sacs closely adherent to the back of the bladder and belonging to the genital apparatus; they cannot be seen at present. From the summit of the seminal vesicles and back of the bladder the peritoneum stretches in the midline across the bottom of the **recto-vesical fossa** to the **rectum** and, clothing the sides of the rectum above, it leaves that organ below along an oblique line on each side, and so bounds the **pararectal fossae** on the sides of the rectum. Finally it reaches the sacrum, the two layers lining the sides of the rectum approaching one another above to form the **mesentery of the pelvic meso-colon.**

Detach the peritoneum from the right half of the pelvic wall and note the structures that adhere to it when detached. They are the **rectum** dorsally; the **urachus** and **bladder** ventrally; and the **ureter** and **vas deferens** laterally.

Raise the bladder and pull it back from the symphysis and thereby open up the **retro-pubic space** (of Retzius). Observe the urachus as a fibrous cord ascending from the apex of the bladder in the extra-peritoneal fat to the umbilicus. The extra-peritoneal retro-pubic space is bounded *medially* by the infero-lateral surface of the bladder; *laterally*, from above downwards, by the pubic bone, the fascia covering the Obturator Internus, and the fascia covering the Levator Ani; *above*, by the peritoneum passing from the lateral border of the bladder to the side wall of the pelvis. The two sides of the space are continuous *in front* between the symphysis pubis and the anterior border of the bladder. With the exploring finger observe that the space is limited *posteriorly* by a broad areolar fold enclosing the leash of vessels that pass from the internal iliac artery and vein to the postero-lateral border of the bladder. This is the **recto-vesical layer of the pelvic fascia** already noted. Feel on each side of the symphysis pubis, two thickenings in the fascia (**pubo-vesical** or **pubo-prostatic ligaments**) that attach the neck of the bladder to the pubis.

Before following the sub-peritoneal ureter and the sub-peritoneal vas deferens, recall that during the migration of the kidney upwards and of the testis downwards, the testis crossed in front of the ureter and drew the testicular vessels and the vas deferens after it. The testicular vessels cross in front of the ureter in the abdomen; the vas deferens crosses in front of the ureter in the pelvis, in fact, close to where it enters the bladder. Follow the **right ureter** from the point at which it crosses the **external iliac artery**, just in front of the

bifurcation of the **common iliac artery**, to the lateral angle of the bladder where its last inch is enveloped in the leash of vessels just mentioned, and is crossed by the vas deferens. Trace the **right vas deferens** from the **deep inguinal ring,** where it turns round the **inferior epigastric vessels** and parts from the other constituents of the cord, to the lateral angle of the bladder where it crosses anterior to the ureter. In order to follow the vas deferens in the final stage of its long course of 18 inches, first fix both ureter and vas in position in such a manner that they are under some tension, then pull the bladder forwards and thereby obtain room to incise the peritoneum transversely at the base of the bladder; then with the handle of the knife ease the internal genital organs (**seminal vesicles** lying laterally and **vasa deferentia** crossing their apices and descending along their medial borders to the **prostate**) enveloped in recto-vesical fascia, backwards off the bladder in front, and then forwards off the rectum behind. This is easily done by blunt dissection without damaging the investing fascia. Leave the internal genital organs thus freed; they will be further investigated later, when they become more readily accessible.

On the right side, the peritoneum with the adhering ureter and vas deferens, has been detached from the pelvic wall and drawn medially, and the retro-pubic space of Retzius has been explored. The side wall of the true pelvis is now to be examined on the right. For this forceps may be required but no dissection is necessary.

Identify the structures forming the wall in their order from above downwards:

(a) **Psoas** and its **fascia.**
(b) **Pelvic brim** and bare **pubic bone** (anteriorly).
(c) **Obturator Internus** and its **fascia.**

The structures on the wall are, from above downwards:

(a) **external iliac artery.**
(b) **external iliac vein.**
(c) **obturator nerve.**
(d) **obturator artery.**
(e) **obturator vein.**
(f) origin of **Levator Ani.**

Observe that the origin of the Levator Ani extends from the inner surface of the body of the pubis to the inner surface of the ischial spine. Between these two points its origin is from the obturator fascia by means of a thickened tendinous arch. Verify also the fact that the ureter and vas deferens descend extra-peritoneally on the medial side of the structures just enumerated.

Identify the **allantoic—placental—umbilical**—or **obliterated hypogastric artery**, whichever you prefer to call it, running forwards from the internal iliac artery to the umbilicus. It tends to adhere to the side of the bladder and to supply it with **superior vesical branches** beyond which it is obliterated.

Read now an account of the pelvic fascia and by reference to the subject establish the following points:

1. Just as the iliac bone together with the fascia iliaca forms a strong osseo-fascial pocket for the **Ilio-psoas,** so do the ischial and pubic bones together with the obturator fascia form an osseo-fascial pocket for the **Obturator Internus.**
2. In the perineum, the pelvic fascia has already been observed to give a complete lining to the ischio-rectal fossa; the lining is stronger laterally over the Obturator Internus than medially over the Levator Ani and Sphincter Ani Externus. It has also been seen to form

"the superior and inferior fasciae of the urogenital diaphragm", which are continuous with each other at the apex and base of the diaphragm.

3. The floor of the retro-pubic space of Retzius is lined with a broad sheet of fascia which is continuous at the neck of the bladder with the vesical fascia. The portion of this sheet which passes forwards to the pubis has developed in it two bands, the pubo-vesical or pubo-prostatic ligaments, which help to anchor the bladder and prostate and can easily be felt. The portion that spreads laterally covers the Levator Ani and blends with the obturator fascia and with the periosteum of the pubis.
4. Pass the handle of the knife through the roof of the ischio-rectal fossa into the retro-pubic space of Retzius and note how thin the partition is.
5. Pull the bladder to the left and note that at the posterior limit of the retro-pubic space, the fascia invests the numerous veins and few arteries that are passing from the base of the bladder and internal genital organs (within the recto-vesical fascia) to the internal iliac vessels.
6. Be satisfied that four layers of fascia separate the bladder from the rectum. They are the layer clothing the base of the bladder; the layer clothing the front of the rectum; and two other layers of which one clothes the vasa deferentia and seminal vesicles in front, the other clothes them behind.
7. The dense fascia clothing the back of the prostate was partially investigated from the perineum. Note now that a finger or the handle of a knife passed downwards between the rectum and the genital organs enters the perineum. That it should be possible for it to do so will be appreciated when it is understood that in fetal life

the recto-vesical pouch extended downwards between the rectum and the prostate. It became obliterated, but it can be opened up again.

8. Pass two fingers downwards behind the rectum and ease it forwards off the front of the sacrum and coccyx. The fingers occupy a little pouch bounded on each side by an areolar fold that contains the **pelvic splanchnic nerves (nervi erigentes)** (S.2, 3 and 4) and conducts them from the 2nd, 3rd and 4th anterior sacral foramina to the side of the rectum. Pack cotton waste into the space opened up by your fingers between rectum and sacrum. Thus you will avoid injury to the rectum when later you saw through the sacrum.

Open the bladder by cutting a V-shaped flap in its upper surface and raising it like the lid of a box. The mucous membrane is seen to lie in folds, except over the **trigone** where it is smooth. The **trigone** is an equilateral triangle on the interior of the base of the bladder. Its sides are an inch or so long; the two ureters and the urethra open at its angles. The internal orifice of the urethra lies at the lowest point of the bladder and therefore is situated advantageously for drainage. A pencil can be pushed into it. The orifice of each ureter is guarded by a fold of mucous membrane and is collapsed. A ridge, the **inter-ureteric torus,** connects the two ureters at the upper border of the trigone. An elevation, the **uvula,** overlying the middle lobe of the prostate, is sometimes to be seen at the apex of the trigone behind the urethral orifice.

The **ureters** are not continuous structurally with the bladder at the postero-lateral angles, but penetrate its wall obliquely to open an inch apart at the base of the trigone. Make a transverse incision through the mucous coat of the bladder at the upper border of the inter-ureteric torus, and carry it laterally through the bladder wall to the postero-

lateral angles. With the aid of the handle of the knife ease the ureters free from their areolar beds. Muscle fibres radiate from the ureters and blend with the muscle of the trigone. The *trigonal muscle* is a submucous sheet distinct from the muscle wall proper. It is continuous with the muscle wall of the ureters above; its apex descends in the posterior wall of the urethra. It is easily separated if the bladder is well preserved. Read an account of the urinary bladder.

SEPARATION OF THE TWO LIMBS. With the knife cut through the symphysis pubis. Observe that the two pubic bones can now be separated at least ½″, and that one may be raised ½″ without affecting the other. Obviously these movements are permitted by the sacro-iliac joints. Turn the subject over. Scrape clean the posterior surface of the sacrum and coccyx in the midline, and saw vertically through the 5th lumbar vertebra, the sacrum and the coccyx. Be very careful to hold the limbs together while you once more turn the subject over on the back, lest the pelvic muscles and vessels be torn. The pelvic cavity is now more widely open.

PROSTATE AND URETHRA. Gently push the rounded handle of the seeker from the internal urethral orifice down the prostatic urethra, rotating the seeker as you do so. Cut through the **pubo-prostatic ligaments.** (These are palpable thickenings of the fascia on each side of the midline in the situation their names indicate.) Cut the deep dorsal vein of the penis and the **inferior pubic (arcuate) ligament,** if it remains. Strip the fascia down off the most anterior part of the **Levatores Ani** and trace the free anterior borders of these muscles downwards to where they meet just behind the

prostate. This will expose the **prostate** in its fascial **sheath.** Note the thickness of the fascia behind the prostate (Denonvillier's). Open one side of the sheath and observe the **prostatic plexus of veins** between sheath and capsule. With scissors or knife cut through the anterior part of the prostate and prostatic urethra and examine the interior of the **prostatic urethra.** Read an account of the male urethra and prostate gland.

Now get your partner to hold the vasa, the ureters and the base of the bladder well forwards, in order that you may fully display the **ampullae of the vasa** and the **seminal vesicles** lying in the **recto-vesical fascia** between bladder and rectum. With two pairs of forceps separate the two ampullae from each other and identify the seminal vesicles lateral to them. On each side follow the **ejaculatory duct** (common to ampulla and seminal vesicle) to the upper surface of the prostate. They are delicate and liable to be torn across. Read an account of the vas deferens and of the seminal vesicle.

Now clean the vessels which run medially from the side wall of the pelvis and which, with their covering of recto-vesical fascia, limit the **retro-pubic space** posteriorly. This vascular partition has already been identified. Follow the **pelvic splanchnic nerves** as far forwards as you can. Identify the ischial spine and clean the surface of the right **Levator Ani.** Read an account of the Levator Ani. Cut the right Levator Ani near its origin and separate the two lower limbs entirely.

Follow the **superior rectal (haemorrhoidal) artery** and **vein.** Notice now a strong suspensory sheet of fascia extending from the front of the lower end of sacrum to the rectum. Slit the **anal canal** and examine the interior.

In many instances the structures described in the interior of the rectum and anal canal are not easily appreciated in the cadaver. Endeavour to make out the following:

1. **Three lateral curvatures**: (a) 3 or 4 inches from the anus the right wall is indented with the result that a transverse fold or shelf, **plica transversa,** projects into the lumen; (b) and (c) similar but less pronounced indentations from the left about an inch below and above (a).
2. Below the recto-vesical fossa the rectum is dilated forwards as the **ampulla.**
3. Longitudinal folds of mucous membrane (5–10) are present in the upper part of the anal canal. These are the **anal columns** (of Morgagni).
4. Semilunar folds, **anal valves** (of Ball), unite the lower ends of adjacent columns.

Read an account of the rectum and anal canal and of their blood supply and venous drainage.

THE PELVIC WALL. Note: The vessels and nerves should be dissected and studied on both sides. If, however, the student is pressed for time, he should pay particular attention to arteries on the right side and to nerves on the left.

The Arteries. The **visceral branches** of the internal iliac artery can be studied on the left side only. The two or three **superior vesical** branches have been identified already as the last vessels to be given off the **umbilical** before it becomes obliterated. Further back on this stem, and therefore nearer the pelvic floor, look for twigs to the rectum, the *middle rectal;* look for twigs to the lower parts of the bladder and to the prostate gland, the **inferior vesical.** These arteries are small (much less conspicuous than the leash of veins), not easy to locate, and may be torn.

The remaining arteries should be sought on both sides; veins may be sacrificed in the interests of clarity. They are:

1. **Superior gluteal,** much the largest branch; it runs backwards for a very short course before leaving the pelvis at the summit of the greater sciatic foramen and above the Piriformis—the muscle passing out and almost filling the foramen.
2. **Inferior gluteal,** running towards the ischial spine in front of the sacral plexus of nerves and in company with:
3. **Internal pudendal.** Pick up this last artery in the perineum where it has already been dissected and establish its continuity throughout. Notice it turns round the ischial spine.
4. **Obturator,** passing forwards on the lateral pelvic wall to the obturator foramen.
5. **Ilio-lumbar,** arising near, or even from, the superior gluteal and crossing the ala of the sacrum to run laterally.
6. *Lateral sacral,* usually in two branches—an upper and a lower—and descending sagittally lateral to the anterior sacral foramina.

Remember the positions of the ureter and vas deferens. They bear important relations to the vessels. The **external iliac artery** proceeds to the lower limb. Note its position and that of its companion vein. Observe the origin of the already identified **inferior epigastric artery** and its relation to the vas deferens. Look for a branch from this vessel to the back of the pubis. It may be large and may replace the obturator artery. Identify the **deep circumflex iliac artery** arising at the same level as the inferior epigastric and taking the line of the inguinal ligament for its guide as it proceeds laterally.

The Nerves. The **obturator nerve** lies above its artery and

vein. The **lumbo-sacral trunk** begins at the anterior border of the ala of the sacrum and has already been found. If the seeker be introduced into the sacral canal and made to pass in turn through the **anterior sacral foramina,** there will be no difficulty in knowing where to look for the remaining nerves. If the sacral canal has not been opened, the anterior foramina should be identified by pushing the seeker through the posterior foramina into the anterior ones. Find and clean the **anterior rami** of the first four sacral nerves as they issue from the anterior sacral foramina. Clean the broad flat **sacral plexus** (and its continuation, the **sciatic nerve**) and determine which anterior rami contribute to its formation. Observe the relation of the sacral plexus to the Piriformis and note that frequently that muscle splits, or is split by, the sciatic nerve. Relatively small branches arise from both the front and the back of the broad sacral plexus. They run very short courses in the pelvis and are better investigated later. One branch, however, the **pudendal nerve,** must be dealt with now. It is readily found proceeding towards the ischial spine in company with the internal pudendal artery, and with that artery entering the perineum where its important distribution has already been followed. Notice that it is formed by three roots from the 2nd, 3rd and 4th sacral nerves.

The small and unimportant **coccygeal plexus** need not delay the dissector long. It is formed by part of the fourth sacral nerve, the fifth sacral nerve and the coccygeal nerve which the good dissector will want to identify. For an account of the minute branches of the plexus he should consult his text book.

Clean the **Obturator Internus** and the **Piriformis,** then read an account of the vessels and nerves of the pelvis.

Study the relations of the **sacro-iliac joint,** noting particularly the lumbo-sacral trunk, first sacral anterior ramus

and the superior gluteal vessels. Define the **sacro-spinous ligament** by removing the few muscular fibres of the **Coccygeus** which lie in front of it. The **sacro-tuberous** ligament can be displayed in part now; part was seen in the dissection of the ischio-rectal fossa; the posterior aspect of the ligament will be examined when the gluteal region is dissected.

The dissection of the sacro-iliac joint—which is an important one—is better left until after the gluteal and thigh regions have been dissected. Read an account of the joint, the ligaments and the mechanisms of the pelvis.

THE FEMALE PELVIS

The instructions and observations given for the pelvis on pages 120–122 are equally applicable to the female and should be followed.

In the female the peritoneum passes from the back of the anterior abdominal wall and the back of the pubis on to the superior surface of the empty urinary bladder; as the bladder fills the peritoneum is stripped off pubis and abdominal wall leaving them bare for a variable distance. On either side of the bladder a paravesical peritoneal fossa is apparent and particularly obvious when the bladder is full. So far the conditions are entirely similar to those in the male. Instead however of passing from the superior surface of the bladder to the seminal vesicles, the peritoneum in the female must pass from bladder to uterus. The extent to which the uterus is covered with peritoneum and the level to which peritoneum descends between bladder and uterus in front and between uterus and rectum behind are of importance. In order to determine these points proceed as follows: Insert the left index finger into the posterior fornix of the vagina, and with the right index in the **recto-vaginal pouch** of peritoneum, determine the extent to which the posterior vaginal wall is

covered with peritoneum. Determine also that the anterior vaginal fornix is not related to peritoneum. Pack the vagina gently with cotton waste.

From the **recto-vaginal pouch** (recto-uterine or pouch of Douglas) the peritoneum reaches the front of the rectum and, clothing the sides of the rectum above, it leaves that organ below along an oblique line on each side, and so bounds the **para-rectal fossae** on the sides of the rectum. Finally, as in the male, it reaches the sacrum, the two layers lining the sides of the rectum approaching one another above to form the **mesentery of the pelvic meso-colon.**

The broad fold of peritoneum whose two layers come together at the sides of the uterus from the front and back of that organ is known as the **broad ligament of the uterus.** This extends to the side pelvic wall where its layers separate to clothe that wall. Notice the disposition of this ligament and identify the **ovary** attached to the back of it by a smaller fold, the **mesovarium.** [At the ovary the mesovarium is continuous with the outer (germinal) layer of the ovary; here a whitish line is sometimes discernible.] Before the peritoneum is disturbed observe the situation of the ovary. It lies, with its long axis more or less vertically disposed, in a little fossa lined with peritoneum, the **ovarian fossa,** on the side wall of the pelvis. The fossa is a V-shaped space bounded by the diverging external and internal iliac vessels.

Detach the peritoneum from the right half of the pelvic wall and note the structures that adhere to it when detached. They are: the **rectum** dorsally; the **urachus** and **bladder** ventrally; the **ureter** and **round ligament of the uterus** laterally. This last occupies a position comparable to that of the vas deferens in the male.

Raise the bladder and pull it back from the symphysis and thereby open up the **retro-pubic space** (of Retzius). Observe

the **urachus** as a fibrous cord ascending from the apex of the bladder in the extra-peritoneal fat to the umbilicus. The extra-peritoneal retro-pubic space is bounded *medially*, by the infero-lateral surface of the bladder; *laterally*, from above downwards by the pubic bone, the fascia covering the Obturator Internus, and the fascia covering the Levator Ani; *above*, by the peritoneum passing from the lateral border of the bladder to the side wall of the pelvis. The two sides of the space are continuous *in front*, between the symphysis pubis and the anterior border of the bladder. With the exploring finger observe that the space is limited *posteriorly*, by a broad areolar fold enclosing the leash of vessels that pass from the internal iliac artery and vein to the postero-lateral border of the bladder. This is the **recto-vesical layer** of the **pelvic fascia.**

Incise the broad ligament where it is attached to the side wall and floor of the pelvis and then follow the right **ureter** from the point at which it crosses the external iliac vessels just in front of the common iliac artery, across the **lateral fornix of the vagina,** to the lateral angle of the bladder, where its last inch is enveloped in the leash of vessels just mentioned and is crossed above by the **uterine artery** to be seen in a moment. Trace the **round ligament of the uterus** from the deep inguinal ring to the side of the uterus where, below the uterine tube, its continuity with the **ligament of the ovary** is readily established.

Next pick up the **ovarian vessels** in the abdomen and trace them extra-peritoneally through a condensation of extra-peritoneal tissues—the **infundibulo-pelvic ligament**—to the broad ligament and so to the ovary. The infundibulo-pelvic ligament suspends the upper pole of the ovary. Pick up the already identified round ligament of the uterus and follow its continuation, the ligament of the ovary to that organ

and, at the same time clean the **uterine tube,** the highest structure in the broad ligament.

Notice that the trumpet-shaped fimbriated end of the tube pierces the peritoneum so that its mouth opens into the peritoneal cavity. Observe that the fimbriated end is attached to the ovary by a **fimbria ovarica.** In a well injected specimen, you will be able to follow also the **ovarian artery** to the side of the uterus below the uterine tube where it anastomoses with the uterine artery. The **uterine artery** pursues a tortuous course up the side of the upper part of the vagina, where it crosses above the ureter, and then up the side of the uterus to the anastomosis just noted. It will be seen again later on.

Read an account of the uterus, uterine tube and ovary.

For the examination of the structures forming, and lying on, the side wall of the pelvis forceps may be required but no dissection is necessary. They are identical with those in the male and are given on pages 124–125.

The details of the **pelvic fascia** can also be readily followed from the account given for the male (pages 125–127) with the exception that in item 6 the word "vagina" must be substituted for "vasa deferentia and seminal vesicles"; item 7 is to be omitted.

Pass the handle of the seeker from the bladder through the female **urethra;** note the direction, length, and calibre of the urethra.

Deal with the **bladder** as in the male by following the instructions given on page 127.

When the bladder has been opened and examined hold the ureters taut, in order to render the **inter-ureteric torus** prominent, remove the bladder wall above the torus and on the sides. The ureters, trigone and urethra must be preserved intact. The anterior wall of the **vagina** and the **vaginal fornices** are now displayed and the point of crossing

of ureter and uterine artery can now be verified if it was not before. Similarly if difficulty was experienced in tracing the uterine artery before, perhaps it can now be traced up the side of the uterus and its **vaginal branch** found. If difficulty is still experienced in following this artery wait until the pelvis is sectioned and try again. Read an account of the female urethra and vagina.

Follow the instructions given on page 128 for the separation of the limbs. Then turn to page 129 and follow the male account from paragraph 2 to the end. Where the vas deferens is referred to substitute 'round ligament'; any other change is obvious.

CHAPTER IV

THE LOWER LIMB

The essential differences in function between the upper and the lower limb are reflected in essential modifications of structure. The duties the lower limb is called upon to perform are three-fold: (1) **weight-bearing;** (2) **locomotion;** (3) **maintenance of equilibrium.** If, in his dissection, the student bears these three functional requirements in mind he will often find in one or more of them the explanation of many structural details, particularly of joints, ligaments and muscles.

If the abdomen and pelvis have already been dissected the student is familiar with the pelvic girdle; nevertheless it will repay him to refresh his memory by re-identifying the following landmarks which mark the upper limits of the lower limb and its girdle. These he should identify on himself as well as on the cadaver and he should freely refer to the skeleton:

1. **Symphysis pubis, pubic crest** and **pubic tubercle.**
2. **Inguinal ligament,** stretching across the root of the limb in front, from the pubic tubercle to:
3. **Anterior superior iliac spine.**
4. **Iliac crest,** running round to the back to:
5. **Posterior superior iliac spine** and back of the sacrum.
6. **Sacro-tuberous ligament,** covered by a large muscle and leading to:
7. **Ischial tuberosity.**
8. **Ischio-pubic ramus,** leading once more to the symphysis pubis.

The circumferential line marked out by these landmarks

separates lower limb from abdomen, trunk and perineum, and has the deep fascia of the lower limb attached to it.

Before dissection begins it is highly desirable to recognize the position in the thigh occupied by the femur. Therefore with the bone beside him for reference, the dissector should notice that the greater trochanter, situated at the junction of the shaft and neck, is readily felt somewhat further laterally even than the iliac crest. The shaft of the femur, with the powerful muscles that clothe it, must descend therefore quite obliquely through the thigh. Filling in what would otherwise be a rather unsightly angularity on the medial side of the thigh, a triangular mass of muscles extends, mainly from the pubis, to the length of the shaft of the femur. This is the adductor mass and it disguises the fact that we are all essentially knock-kneed.

It is now apparent that the blood vessels, escaping from the abdomen or pelvis to enter the thigh behind the inguinal ligament, must, of necessity, lie entirely medial to the femur and the muscles clothing it. They do not reach the bone till the knee is approached and they pass to the back of the knee, on the medial side of the bone, by making their way through the adductor mass. Thus, in the thigh, there are three regions to be dissected. Each is confined by intermuscular septa passing from the enveloping deep fascia as broad sheets to the back of the femoral shaft, and each possesses its own nerve. Thus, there exist:

1. An **extensor** or **anterior region,** consisting of the muscles clothing the femur and supplied by the femoral nerve;
2. An **adductor** or **medial region,** consisting of adductor muscles and supplied by the obturator nerve;
3. A **flexor** or **posterior region,** consisting of the hamstring muscles and supplied by the sciatic nerve. Between extensor and adductor regions is the thin medial inter-

muscular septum; between adductor and flexor regions is the thin posterior intermuscular septum; between flexor and extensor regions is the stout lateral intermuscular septum.

When the student has grasped this essential arrangement he may proceed to the dissection of the extensor region which is the front of the thigh.

THE FRONT OF THE THIGH

Extensor Region. If not already done, make a skin incision beginning on the iliac crest 1″ behind the anterior superior iliac spine and carry it medially along the inguinal ligament to the pubic tubercle, and thence—skirting the pudendal and perineal regions—towards the ischial tuberosity (fig. VI, F to G). At the level of the tibial tubercle make a horizontal cut across the anterior half of the leg (fig. VI, H to I). Join the two incisions by a vertical one down the whole length of the middle of the front of the thigh (fig. VI, K to L). Reflect the skin medially and laterally.

The **long saphenous vein** may be apparent; in any case, it is readily found in the superficial fascia a full hand's-breadth behind the medial margin of the patella. Trace it up the thigh (noting a tributary joining its medial side) to a point 1½″ infero-lateral to the pubic tubercle where it turns backwards through an oval aperture in the deep fascia the **saphenous opening** (fossa ovalis). Below this point pass the handle of the knife behind the cleaned vein, carry it upwards until arrested by the vein where it hooks over the lower sharp margin of the opening. Just before the vein turns deep, it is joined by three superficial tributaries: **superficial external pudendal, superficial epigastric** and **superficial circumflex iliac.** Their names indicate their positions. They are accompanied by correspondingly named arteries whose origins

from the femoral artery cannot be seen now, and, since the region of the opening is an important "hernial" one, even the saphenous vein is not to be followed any further at present.

When the abdomen was dissected, the fatty layer of superficial fascia, **Camper's fascia,** and the membranous layer, **Scarpa's fascia,** were identified, and it was seen that

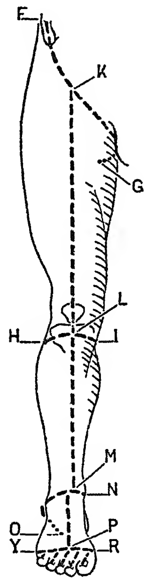

FIG. VI

Camper's fascia was continuous with the fatty layer in the thigh and that Scarpa's fascia was attached to the deep fascia of the thigh, the **fascia lata,** one finger's breadth below the inguinal ligament. This line commonly crosses the saphenous opening. The significance of this is related to the course taken by a femoral hernia: one bursting through the

opening above the line of attachment will be directed to the abdomen; one below, to the thigh.

Dissect the **superficial inguinal lymph nodes.** They lie immediately below the line just described and on both sides of the long saphenous vein. In favorable cases the lymph vessels can be traced from them. Read an account of these lymph nodes and the territories they drain.

The cutaneous nerves to be dissected now are the **lateral, intermediate** and **medial cutaneous nerves of the thigh,** and in doing this the superficial fascia will be removed. All work must be carried out lateral to the saphenous opening and the region of the opening left undisturbed. In a fat subject *cutaneous veins* float, so to speak, near the surface of the "fluid" fat, and they have no occasion to turn deep until they approach their terminations. On the other hand, *cutaneous nerves* sink; since, coming from the depths, they pierce the deep fascia and, having pierced, remain close to it. The nerves pierce the deep fascia along the line of the **Sartorius** muscle. This muscle crosses the front of the thigh obliquely, from the anterior superior iliac spine to the medial side of the knee. The actual points of piercing of the nerves vary vertically, however, within 2 or 3 inches. Therefore, make a series of appropriate vertical cuts down to the deep fascia, which is very thin medially but thick and stringy laterally, and, with the handle of the knife and the seeker, peel the fat piecemeal but always in a vertical direction. As the nerves are encountered, follow them proximally to the sites where they pierce the deep fascia and distally as far as is profitable to determine their cutaneous distributions. If the abdomen has been dissected, it may be a useful procedure to pick up the lateral cutaneous nerve above the inguinal ligament and hold it taut, in order to obtain an indication where to seek for it in the thigh. Two or three twigs

from the **genito-femoral nerve** pierce the fascia lata close below the mid-inguinal point, but they are not likely to be found. The **ilio-inguinal nerve,** having come through the superficial inguinal ring, pierces the external spermatic fascia and, if not traced during the dissection of the abdomen, must be followed now both to the thigh and to the scrotum (or labium majus).

Clean the remains of the superficial fascia from the front of the thigh down to the level of the upper border of the patella. If the subject is fat, wipe dry the exposed fascia lata.

Make a vertical incision on the patella down to bone, and prolong the incision to the tibial tubercle. Explore: (a) the **prepatellar bursae** which lie in front of the patella and may be **subcutaneous, subfascial** or **subtendinous;** notice if two superimposed bursae have formed one, as indicated by remnants of a partition; (b) the **superficial infrapatellar bursa** which lies in front of the patellar ligament and the apex of the patella.

It is the object now to display the areolar investment of the femoral artery, vein and lymph vessels known as the **femoral sheath.** It will be recalled that, in the abdomen, the vessels lie in the extra-peritoneal fat and, therefore, within the fascial 'bag' whose outer surface covers the muscles. In order to escape into the thigh the vessels must therefore evaginate a funnel-shaped prolongation of this fascial 'bag'. This investment of the blood vessels is known as the **femoral sheath.** The femoral nerve, lying at all times outside the fascial 'bag' has no such difficulty to overcome and is, therefore, NOT a content of the femoral sheath.

Clean well the fascia lata a little lateral to the lower edge of the saphenous opening and follow its lateral curved **falciform edge** to the pubic tubercle. Laterally, but neither

above nor below, the point of the knife will be required to define the edge. Insert in the opening the handle of the knife and gently ease back the underlying femoral sheath which must not be injured. With the knife-handle clean the thin areolar part of the fascia lata medial to the saphenous opening. It is called the **pectineal** (i.e., pubic) **fascia** and it is continued laterally behind the sheath. Appreciate that the artery lies behind the lateral edge of the saphenous opening, the vein and lymph vessels behind the opening itself. Therefore, pass the knife-handle behind the sharp, lateral edge and sever it transversely 1 cm. below the inguinal ligament. Lift the upper flap and observe that the base of the sheath is only loosely attached to the inguinal ligament. The medial border of the sheath runs obliquely downwards and laterally from the pubic tubercle to the apex of the sheath, which is situated near the lower edge of the saphenous opening. An interval, therefore, exists within the sheath between its medial border and the femoral vein; this interval is the **femoral canal.** The lateral border of the sheath runs vertically from the mid-inguinal point and is, therefore, closely applied to the artery. After flexing the joint, by placing a block beneath the knee in order to render the parts lax, pass the handle of the knife behind the medial and lateral borders of the sheath, and separate the sheath from the underlying fasciae: these are **ilio-psoas fascia** laterally and the **pectineal fascia** medially. Note the areolar septum passing backwards from the sheath, and then sever it. Detach the front of the base of the sheath from the inguinal ligament and raise the sheath from the ilio-psoas fascia behind, and so establish its continuity with the extra-peritoneal fatty-areolar tissue.

Open the three **compartments of the sheath** by three vertical cuts: one over the artery, one over the vein, and the

third over the medial part where lymph vessels lie. The medial compartment is the **femoral canal.** It may contain a lymph gland. Pass the handle of the seeker up the canal and study the boundaries and relations of its mouth, called the **femoral ring.** They are: (1) anteriorly, the inguinal ligament; (2) posteriorly, the superior pubic ramus covered by Pectineus and its fascia; (3) medially, the pectineal part of the inguinal ligament (lacunar lig:); (4) laterally, the medial septum between it and the femoral vein.

The triangle bounded by the inguinal ligament Sartorius and Adductor Longss is known as THE FEMORAL TRIANGLE OF SCARPA. Trace the already exposed **femoral artery** distally for about $3\frac{1}{2}''$ to where it is crossed by the Sartorius. Lateral to the artery and $1''$ below the inguinal ligament, cut vertically through the fascia covering the Iliacus and expose the **femoral nerve;** it is about half as broad as the artery. Place a match-stick crosswise behind the nerve in order to render it prominent, then trace from its medial side the slender *nerve to the Pectineus* passing behind the sheath. The femoral nerve resolves into a leash of branches some of which have already been identified lower down. The following three branches should be noted now: (1) **intermediate cutaneous nerve of the thigh,** passing across or through the Sartorius and providing a motor branch to that muscle; (2) **motor branch to Rectus Femoris;** (3) **medial cutaneous nerve of the thigh,** following the medial border of the Sartorius and crossing in front of the femoral artery. The **saphenous nerve** which accompanies the femoral artery, and the **nerves to the three Vasti** (the extensor muscles clothing the femur) should be left till later.

When these nerves have been cleaned and identified, clean the **Sartorius** from its origin to the point where it crosses the **femoral artery.**

Clean the medial side of the femoral triangle by removing the fascia from the **Pectineus** and **Adductor Longus.** The Pectineus is a triangular muscle with its base superiorly and arising in the vicinity of the pectineal line. The Adductor Longus lies medial to the Pectineus and is also triangular but with its apex superiorly; this apex is a stout tendon arising from the front of the pubis near the symphysis. Both muscles pass downwards and lateralwards.

Clean the **femoral artery** and **vein** and their branches within the limits of the femoral triangle. Just below the inguinal ligament the artery gives rise to three small superficial branches already traced in the abdominal or scrotal walls: (1) *superficial circumflex iliac;* (2) *superficial epigastric;* (3) *superficial external pudendal.* Recall that their companion veins join the long saphenous vein already investigated. Several *muscular* branches supply the adjacent muscles and a *deep external pudendal* runs medially to the scrotal wall or labum majus. Do not delay over any of the foregoing but pay attention to the three following which may arise from a large common stem, or one may arise independently, or all three may be dissociated: (1) **profunda femoris,** the largest and pursuing the same general direction as the femoral but on a deeper plane; (2) **lateral femoral circumflex,** passing lateralwards amid the branches of the femoral nerve; (3) **medial femoral circumflex,** the smallest, and plunging backwards through the floor of the triangle between Psoas and Pectineus.

Preserve the long saphenous, femoral and profunda femoris veins, but remove all other veins and so clarify the picture. Display the floor of the triangle by removing the remaining fat and fascia. Open the interval between the Psoas and the Pectineus—indicated by the medial femoral circumflex artery—remove the fatty areolar tissue there and see: (1) the **Psoas tendon** attached to the front of the lesser tro-

chanter; (2) the **Iliacus** lateral to it; (3) the **Pectineus** passing to its insertion below it.

THE SUBSARTORIAL (HUNTER'S) CANAL. Along the line of the Sartorius slit the **deep fascia;** it here forms the anterior wall of the fascial sheath in which the muscle plays. The posterior wall of the sheath, i.e. the fascial bed of the Sartorius, is also the roof of the subsartorial canal. This dense fascia extends from the Adductor muscles medially to the Vastus Medialis—the powerful muscle clothing the medial aspect of the shaft of the femur—laterally. Lift the Sartorius out of its bed and slit the roof of the canal from the apex of the femoral triangle to about four inches above the knee joint. The whole length of the **femoral artery** now lies exposed; it is to be cleaned and traced to the point where it passes backwards through a hiatus in the Adductor Magnus. Its vein is behind it. The **saphenous nerve** is to be traced through the canal. When the artery passes backwards, the saphenous nerve runs onwards in front of the Adductor Magnus tendon, accompanied by the **saphenous artery,** a tenuous branch of the femoral. Within the areolar sheath of the Vastus Medialis, and therefore not strictly in the canal, lies the **nerve to the Vastus Medialis.** Find it. In size it equals the saphenous nerve.

Clean the **Sartorius** to its insertion by removing the superficial, as well as the deep fascia as far as the lower skin-cut; while doing this, follow the **saphenous nerve** until it becomes cutaneous between the Sartorius and the tendon of the **Gracilis,** which lies immediately behind the Sartorius. Follow to its termination the *patellar branch* of the saphenous nerve; it arises above the knee and pierces the Sartorius. The twig that the saphenous nerve gives, while in the canal, to the *subsartorial plexus,* should be looked for.

Observe that in the lateral region of the thigh the deep

fascia (the **fascia lata**) is strong and dense. In the region immediately behind and below the anterior superior iliac spine it encases a muscle, the **Tensor Fasciae Latae,** whose vertical anterior border meets the Sartorius at the spine. Distally this border is continuous with the anterior border of a strap-like thickening of the fascia lata, the **ilio-tibial tract,** which, at the level of the knee lies a finger's breadth from the lateral border of the patella and is one inch in width. Retract the ilio-tibial tract from the **Vastus Lateralis**—the muscle clothing the lateral aspect of the femur—and follow the thick **lateral intermuscular septum** passing from the deep aspect of the fascia to the **linea aspera** or rough line on the back of the femoral shaft. About four inches below the anterior superior spine the ilio-tibial tract sends a septum upwards and medially to the capsule of the hip joint. Twigs from the lateral femoral circumflex artery appear from under cover of the Rectus Femoris and will be seen running into the Tensor.

Define the **Rectus Femoris** descending from the anterior inferior iliac spine to the patella. Work on its lateral side because its nerve, from the femoral, enters its medial side. Dissect its flattened tendon of insertion free from the Vasti and trace it right to the patella. Follow its two tendinous heads to their origins—the straight head is overlapped by the Iliacus; the reflected head, skirting along the acetabular margin of the hip joint, is overlapped by the Gluteus Minimus. Between the Rectus and the Tensor is the internervous line between femoral and gluteal nerve territories.

Pick up the **lateral femoral circumflex artery** at its origin and follow it deep to the Sartorius and Rectus Femoris. Its **ascending branch** runs along the intertrochanteric line and supplies the front of the capsule of the hip joint and neck of the femur; its **transverse branch** anastomoses in the gluteal

region; its large **descending branch,** accompanied by the **nerve to the Vastus Lateralis,** is a guide to the anterior border of the Vastus Lateralis. Free the muscle by following the anterior border upwards. Trace the thin aponeurotic border of the Vastus Lateralis downwards to the patella and free the muscle extensively from the underlying **Vastus Intermedius.**

If you separate the *oblique* fleshy fibers of the **Vastus Medialis** from the *vertical* aponeurotic fibers of the **Vastus Intermedius,** you will observe that the medial surface of the femur is bare of muscle. The **nerve to the Vastus Intermedius,** from the femoral, enters the highest part of the muscle and should be found now. The observant dissector will detect and follow a long twig of the femoral nerve descending on the femur along the medial border of the Intermedius for the supply of its lowest fibers, the *Articularis Genu.* These fibers are seen to be arranged in several short scattered bundles which pass from the front of the lower end of the femur to the capsule of the knee joint. Be careful not to injure the synovial capsule.

When the three Vasti are separated from one another observe that their origins meet above on the **inter-trochanteric line.** Vastus Lateralis clothes the lateral aspect of the shaft of the femur as high as the base of the greater trochanter, which it does not invade, and reaches the upper part of the line. Vastus Medialis clothes the medial aspect of the shaft and reaches the lower part of the line. Vastus Intermedius, confined to the antero-lateral aspect of the shaft, reaches the line between the other two. Lastly observe that the intertrochanteric line itself is produced by the attachment of the thick anterior portion of the fibrous capsule of the hip joint, known as the **ilio-femoral ligament.**

Define the oblique lower fleshy border of the Vastus Medialis and follow it to the patella. Detach this lower origin from

the medial intermuscular septum and from the tendon of the Adductor Magnus, which latter descends to the adductor tubercle. This will reveal the *descending genicular artery.* It is the last branch of the femoral and, besides supplying adjacent muscles and the upper part of the knee joint, it provides a cutaneous branch, the **saphenous artery,** which, as already noted, accompanies the nerve of the same name, and is of more developmental interest than practical importance.

It is well to leave the detailed consideration of the insertions of the three Vasti until later, as there is danger of opening the knee joint.

THE MEDIAL REGION OF THE THIGH OR ADDUCTOR REGION. Remove the fascia from the anterior surfaces of the muscles lying behind the femoral and saphenous arteries. Remove any remaining deep fascia from the medial side of the thigh in order to display the **Adductors.** Display the continuous curvilinear origin of the **Pectineus, Adductor Longus** and **Gracilis.** The Gracilis, as its name implies, is the slender strap-like muscle running down the medial aspect of the thigh. Trace the Pectineus and Adductor Longus fanning out to their aponeurotic insertions on the femur. In doing so, the Vastus Medialis must be rolled laterally and held there while the dissection is carried out with the handle and point of the knife.

Separate the Pectineus from the Adductor Longus. If possible, turn the Pectineus laterally to display the underlying **Adductor Brevis,** but if necessary divide the Pectineus. Clean the **Gracilis,** being careful of its nerve entering it above the middle of the thigh. Find the **anterior division of the obturator nerve** running obliquely downwards and medially from the obturator foramen across the anterior surface of the Adductor Brevis. Cut the Adductor Longus 2″ from its

origin and reflect it towards its insertion. Clean and define the Adductor Brevis. It is sometimes a little difficult to isolate the Adductor Brevis from the **Adductor Magnus.** In that case the dissector will take advantage of the fact that just as the anterior division of the obturator nerve passes between Longus and Brevis so the **posterior division** passes between Brevis and Magnus. He should therefore trace the anterior division of the obturator nerve, already identified, proximally to the obturator foramen, find the trunk of the nerve and secure the posterior division as it passes through the upper fibres of the **Obturator Externus**—the muscle applied to the outer aspect of the obturator foramen. The posterior division, if followed distally, will lead to the plane separating Adductor Brevis in front from Adductor Magnus behind. Working from the upper border of the Adductor Brevis and using the posterior division of the obturator nerve as a guide, free the muscle and trace it to its insertion.

It is a common failing to neglect to clean the thin aponeurotic insertions of Adductor Longus and Adductor Brevis right to their bony attachments on the linea aspera. The student who spends a few moments doing this well is rewarded by the ease with which he can now follow the profunda artery and vein between these two muscles. Indeed, he will find it convenient to clean the insertions of the muscles and follow the vessels at the same time. As the vessels are being cleaned **perforating arteries** will be found closely encircling the femur and interrupting the insertions of the muscles they encounter. As a rule four will be found, the much reduced profunda itself being the fourth or sometimes a fifth. Again sacrifice the veins in the interests of clarity.

Reflect the Adductor Brevis as you did the Adductor Longus and so display and clean the whole length of the massive and powerful **Adductor Magnus.** The thin upper edge

of the muscle passes almost horizontally lateralwards from the inferior ramus of the pubis and crosses behind the lesser trochanter. This edge which overlaps the Obturator Externus above may be identified by once more picking up the **medial femoral circumflex artery** which, passing backwards between the two muscles, serves as a guide to their separation. Next define the **hiatus** in the Adductor Magnus through which the femoral vessels pass to become the popliteal vessels and then trace the tendon of the muscle to its insertion.

The **posterior division of the obturator nerve** now lies exposed throughout its full extent. Notice that, above, it is accompanied by branches of the obturator artery. Below, look for a slender twig that the nerve sends to the popliteal artery and which runs along that vessel to the capsule of the knee joint.

THE GLUTEAL REGION

An examination of an articulated pelvis will reveal that a large notch, the greater sciatic notch, lies at the centre of a circle whose circumference marks the boundaries of the gluteal region. If the pelvis and perineum have been studied already, the dissector will recall that there pass from the sides of the sacrum and coccyx two ligaments: (1) the sacro-tuberous ligament, to the tuberosity of the ischium; (2) the sacro-spinous ligament, to the sharp and prominent ischial spine which bounds the greater sciatic notch below.

Nerves and vessels, issuing trom the pelvis at the greater sciatic notch, may take one of three routes: (1) they may at once devote themselves to the gluteal region; (2) they may turn sharply round the ischial spine (or sacro-spinous lig:) and enter the perineum; (3) they may descend through the lower part of the gluteal region and gain the lower limb.

The back of the blade of the ilium is devoted to three large

muscles of locomotion, the **gluteal muscles.** Deep to the **Gluteus Maximus** six small muscles are to be found: One, the **Piriformis,** issues from the pelvis through the greater sciatic foramen; one, the **Obturator Internus,** issues through the lesser sciatic foramen and uses the ischial spine as a pulley; two, the **Gemelli,** merely reinforce the tendon of the Obturator Internus; one, the **Quadratus Femoris,** arises from the ischial tuberosity; one, the **Obturator Externus,** arises from the outside of the pelvis around the obturator foramen. All six are outward rotators of the thigh and all are inserted on the greater trochanter of the femur, which also receives the insertions of the **Gluteus Medius** and **Gluteus Minimus.**

The student is advised to procure an articulated pelvis, or at least a hip bone, and to visualize on it the above-mentioned dispositions before he begins dissection.

Turn the subject on to the face and put a block under the anterior iliac spines. Make a median vertical skin-cut from the point where the skin of the back has already been reflected to the tip of the coccyx (fig. VII, S to A). Make a second from the coccyx to the lateral part of the thigh 6″ or 7″ below the greater trochanter (fig. VII, A to B). Turn the skin-flap laterally.

Identify and trace the *posterior rami of the upper three lumbar nerves;* these pierce the lumbar fascia (at the lateral border of the Sacrospinalis) about 3 fingers' breadth from the midline and, crossing the iliac crest, descend towards the greater trochanter. The lowest of the three pierces immediately above the iliac crest; the other two pierce in line above. They were found when the upper limb was dissected, so it is necessary merely to observe their distributions.

The *lateral cutaneous branch* of the **12th thoracic nerve** crosses the iliac crest just in front of its tubercle, and that of the **ilio-hypogastric** just behind. These two nerves were identified when the anterior abdominal wall was dissected; follow them now to their

distributions. Follow the posterior branch of the lateral cutaneous nerve of the thigh which also contributes to the supply of the buttock.

Cut through the superficial fascia in the midline, if not already done, until the lumbar fascia (aponeurotic in structure) is reached. With the knife-handle ease the fat off the fascia and, about a finger's breadth from the midline, find the twigs of the *posterior rami of the upper three sacral nerves* piercing to become cutaneous. The first one is below the level of the posterior superior iliac spine. These twigs are insignificant and must not delay you.

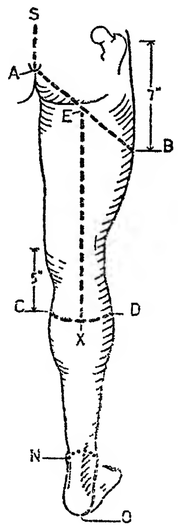

FIG. VII

Rotate the thigh medially in order to render the Gluteus Maximus tense, then make an incision 2″ above and parallel to the lower skin cut; the incision should go through superficial and deep fasciae down to the fibers of the **Gluteus Maximus.** If the ensuing instruction is not followed in detail the careless dissector will reveal himself by cutting the **posterior cutaneous nerve of the thigh!** This can be avoided by

reflecting the lower piece of fascia and defining, first at its lateral part, the lower free border of the Gluteus Maximus. Then, by cleaning the lower border medially, the nerve in danger may be picked up as it crosses the border midway between the ischial tuberosity and the greater trochanter; just below this point it crosses the Biceps Femoris deep to the deep fascia. Trace the gluteal branches of the nerve into the fat. Continuing to work medially along the border of the Gluteus Maximus try to find the small *perforating cutaneous branches* of the **2nd** and **3rd sacral nerves.**

Remove the superficial fat from the whole region. The deep fascia over the Gluteus Maximus is thin. Define the free upper border of the Gluteus Maximus; it runs parallel to the lower border and passes about 1″ above the level of the greater trochanter. The muscle arises from but a relatively small area on the dorsum of the ilium in the vicinity of the posterior superior iliac spine. Above the Gluteus Maximus is the **Gluteus Medius.** The fascia covering the Gluteus Medius is thick; at the upper border of the Gluteus Maximus it splits to enclose that muscle. After the Gluteus Maximus is studied it is to be divided into upper and lower halves by separating its fibres. Starting laterally over the greater trochanter, cut through the aponeurosis of the Gluteus Maximus right down to bone. In so doing, you open one of the largest bursae in the body, that between the aponeurosis of the Gluteus Maximus and the greater trochanter. Now rotate the thigh laterally in order to render the Gluteus Maximus lax, and pass a finger through the cut into the underlying fatty areolar tissue and by this means establish the plane of the deep surface of the muscle. The finger, swept around circularly in this plane, will feel the **inferior gluteal nerve** entering the Gluteus Maximus about its center point. Avoiding the nerve, prolong the cut in the Maximus medially to the sacrum, using a finger as a guide to depth.

Just lateral to the inferior gluteal nerve the **sciatic nerve** is easily located. It is as broad as the knife-handle, and courses from a point midway between the ischial tuberosity and greater trochanter to the middle of the back of the knee. Rapidly clean the region lateral to the nerve, where there is nothing to damage, and trace the lateral border of the nerve up to the lower border of the Piriformis.

Pick up the sciatic nerve again, this time at the lower border of the Gluteus Maximus. There, at its most readily accessible part, it runs a brief course in the angle between the lower border of the Gluteus Maximus and the lateral border of the **long head of the Biceps Femoris.** Note that there the long head of the Biceps separates the posterior cutaneous nerve of the thigh, which is behind it, from the sciatic nerve, which is in front.

With the fingers free the lower half of the Gluteus Maximus from the underlying muscles and cut vertically across it lateral to the sciatic nerve. Turn the lateral part of the Gluteus Maximus laterally and observe a second large bursa between its tendinous insertion and the aponeurosis of the Vastus Lateralis. As the medial part is turned medially towards its origin, it must be dissected off the **sacro-tuberous ligament; the posterior cutaneous nerve,** clinging to its deep surface, must be freed and traced up to the lower border of the Piriformis. The **inferior gluteal nerve** and branches of the corresponding artery, which enter the muscle, must be cut—with a button of Gluteus Maximus attached for subsequent identification—and traced also to the lower border of the Piriformis. Clean the **inferior gluteal artery** and its branches, also the **sciatic nerve** from its lateral side, and the entire lower border of the **Piriformis.** The lesser sciatic foramen is bounded below by the sacro-tuberous ligament and above by the ischial spine and sacro-spinous ligament. Identify the

vessels and nerves that pass through it. They curve from under cover of the medial part of the Piriformis across the spine or the sacro-spinous ligament. They are the **nerve to the Obturator Internus** and the **internal pudendal artery and nerve,** in that order latero-medially. Clean the **Quadratus Femoris**; it runs horizontally from the ischial tuberosity to the quadrate tubercle and to the femur for 2″ below this. Between its upper border and the Piriformis lie the tendon of the **Obturator Internus** and the two fleshy **Gemelli,** one Gemellus being above the tendon and the other, below. Separate the lower border of the Quadratus Femoris from the Adductor Magnus. If the line of separation is not readily found, make a horizontal cut which crosses the lesser trochanter. You will observe then a *bursa* behind the trochanter. To find the *nerve to the Quadratus Femoris,* first bend the knee by the use of blocks, and thereby slacken the sciatic nerve; then, at the lower border of the Piriformis, lift the slackened sciatic nerve from the back of the ischium and find the slender nerve you seek leaving the anterior aspect of the sciatic nerve high up. By gently tugging the nerve where it passes deep to the Obturator Internus and Gemelli, you may see where to pick it up again at the lower border of the Gemellus Inferior.

The Obturator Internus issues through the lesser sciatic notch as a broad tendon between the Gemelli. Clean the tendon of the **Obturator Internus** and the fleshy Gemelli—the **Superior Gemellus** to its origin from the ischial spine, the **Inferior Gemellus** to its origin from the ischial tuberosity. With care the upper border of the Obturator tendon may be separated from the Gemellus Superior. (If the limb be rotated laterally, the muscles will be relaxed.) Complete the separation of the three muscles from one another lateralwards. Raise and sever the tendon of the Obturator

Internus and turn aside the two parts. On the deep surface of the medial part examine the finger-like segments of the tendon and explore the large **bursa** separating it from the smooth area of bone below the ischial spine over which the tendon plays. Wide of the bursa the Gemelli together may be seen to have a continuous fleshy crescentic origin; further laterally they envelop, and are inserted into, the superficial aspect of the tendon of the Obturator Internus.

Separate the Quadratus Femoris from the Inferior Gemellus and see the thick rounded tendon of the **Obturator Externus** passing horizontally to its insertion in the trochanteric fossa. The disposition of this muscle may be a little difficult to appreciate but if you refer to the skeleton you will see that the two Obturator muscles get their names, not from their actions which are identical, but from their situations in respect to the obturator foramen

Follow the posterior border of the greater trochanter upwards and note its continuity with the lower border of the Gluteus Medius. Incise vertically the dense deep fascia covering the **Gluteus Medius** in order to see fibers of that muscle arising from it. Inferiorly, this fascia splits to enclose the Gluteus Maximus; anteriorly, it splits to enclose the Tensor Fasciae Latae. Cut vertically through the upper half of the Gluteus Maximus and turn the two parts medially and laterally. Define the upper border of the **Piriformis** and find there the large **superficial branch** of the **superior gluteal artery** to the upper part of the Gluteus Maximus. This superficial branch passes between the Piriformis and the Gluteus Medius and so identifies the interval between these two muscles. Separate freely the Piriformis from the Gluteus Medius and see the underlying **Gluteus Minimus.** Sweep the fingers deep to the **Gluteus Medius** in the plane of the superior gluteal vessels and nerve, thereby separating

it from the **Gluteus Minimus.** Sever the Gluteus Medius about 1″ above the greater trochanter, and clean it to its attachment noting the diagonal line of its insertion. (The Medius may not be completely differentiated from the Minimus anteriorly.) Open the bursa between it and the trochanter. Clean the **superior gluteal artery** and **nerve** and their branches, including a branch of the nerve to the Tensor Fasciae Latae. Note that the artery and nerve turn around the bone at the highest point of the greater sciatic notch.

Clean the Gluteus Minimus and trace it to its insertion. Then trace the Piriformis, Obturator Internus and Gemelli, and Obturator Externus to their insertions on the greater trochanter.

Now is a suitable time to dissect the hip joint on one side. See page 180.

THE POPLITEAL FOSSA AND BACK OF THIGH

It is customary to dissect the popliteal space before the back of the thigh otherwise its boundaries and the positions of its contents are apt to be disturbed.

If one remembers whence the main vessels and nerve approach the fossa no difficulty is experienced in appreciating their relative positions. Thus, the femoral vessels come from in front and on the medial side of the femur, and the vein was last seen behind the artery; the sciatic nerve comes down the back of the thigh in the midline. Hence, when these structures meet in the upper part of the space the sciatic nerve is lateral and superficial and the popliteal vein intervenes between it and the popliteal artery.

Again, since the larger division of the nerve, the **medial popliteal,** maintains its midline position but the artery and vein make for the interval between the (large) tibia and

(small) fibula, and therefore run obliquely lateralwards, the medial popliteal nerve is crossed anteriorly (deeply) by the vessels. The relationships above then, are nerve, vein, artery, from lateral to medial; below they are artery, vein, nerve, from lateral to medial; the artery is always deepest and the vein always intervenes between nerve and artery. [Note that this relationship is contrary to the general rule in which an artery lies between its companion vein and nerve.]

Popliteal Fossa. The subject has been lying on its back, and it is not improbable that the calf is flattened on its lateral side and the soft parts displaced medially. This is because the limb rotates laterally from its own weight, as occurs in fracture of the femur. Remodel the calf, if possible, before dissection begins. Make a horizontal cut across the back of the leg, 5″ below the level of the patella (fig. VII, C to D). Make a vertical cut down the middle of the back of the thigh (fig. VII, E to X). Reflect the skin medially and laterally. Remove the superficial fascia from the back of the thigh, but not from the popliteal fossa. At the upper end of the thigh raise the already displayed **posterior cutaneous nerve of the thigh** and, by pulling on it, observe its subfascial course, but do not dissect it, since it is desirable to keep the deep fascia of the back of the thigh intact for the present. The nerve frequently extends as far as the level of the lower limit of the popliteal fossa. In the superficial fascia covering the lower half of the fossa find the **short saphenous vein** occupying the midline of the limb. If the posterior cutaneous nerve reaches as far distally as this level it will accompany this vein. Trace the vein proximally to the point where it pierces the deep fascia, and observe its branches of communication with the **long saphenous vein.** The superficial fascia may now be removed from the upper half of the fossa. Notice

that the deep fascia is thin, but strong, and consists of transverse fibers.

In line with the short saphenous vein, but deep to the deep fascia, lies the large **cutaneous branch of the medial popliteal nerve** (tibial nerve). It lies buried in the furrow between the two bellies of the Gastrocnemius. Incise the fascia; dig out the nerve; free it and trace it to its origin from the medial popliteal nerve. Follow the **medial popliteal nerve** to the upper angle of the fossa, but do not yet trace it downwards.

Palpate the head of the fibula. Incise vertically the deep fascia behind it, and pick up the **lateral popliteal nerve** (peroneal nerve). (The two popliteal nerves are each about half the size of the sciatic nerve.) Trace the lateral popliteal nerve upwards, at the same time cleaning the medial border of the **Biceps Femoris** along which it runs; preserve and trace, within the limits of the region, the **cutaneous branch of the lateral popliteal nerve** found arising from its medial side. As the lateral popliteal nerve approaches the upper angle of the fossa it also approaches the medial popliteal nerve. Two fine *articular twigs* may be met. Follow the nerve downwards to the point where it bends forwards round the neck of the fibula under cover of the Peroneus Longus. Any remaining superficial fascia may now be removed.

At the upper angle of the fossa the Biceps meets the fleshy **Semimembranosus** behind which lies the round **Semitendinosus** tendon. Halfway down the fossa the tendons of these three muscles embrace the lateral and medial heads of the **Gastrocnemius.** The two bellies of the Gastrocnemius are closely applied to each other. The diamond-shaped area bounded by these muscles is the popliteal fossa.

Place a block in front of the ankle and thereby relax the

Gastrocnemius; then, at the lower angle of the fossa, insert the two index fingers between the contiguous bellies of the Gastrocnemius, raise them and pull them apart. After freely incising the investing deep fascia at the medial border and at the lateral border of the respective heads of the Gastrocnemius, pass the fingers round these borders, lift up the whole muscle and spread the bellies widely. For a successful exposure, the contiguous borders must be free for 4″ or 5″ and the opposite borders for 5″ or 6″; further, the hand must be passed distally deep to the Gastrocnemius, thus raising it from the underlying Soleus. This will afford a view of the underlying Soleus, Popliteus and Plantaris, and will allow you to define the motor branches of the medial popliteal nerve passing to these muscles. Notice that one motor branch proceeds from the medial side of the nerve and four from the lateral side.

The **Soleus** is the large fleshy muscle for the most part covered by the lateral belly of the Gastrocnemius; the **Popliteus** is deep to the medial belly, entirely proximal to the Soleus, and covered by a transparent sheet of fascia; the **Plantaris**, about the size of a little finger, extends along the medial border of the lateral belly; its silvery, string-like tendon descends to the calcaneum. None of these muscles should be further disturbed now. The details of their attachments will be investigated later.

Trace the medial popliteal nerve to the lower limits of the fossa where it passes between the Soleus and Popliteus. Displace the nerve and observe the **popliteal vein** and **artery** lying in a common sheath. The sheath is the densest vascular sheath you will meet. Open it, separate the vein from the artery, follow the branches of the artery and sacrifice the tributaries of the vein. Besides a few cutaneous branches, and branches to adjacent muscles, you should identify the five

genicular branches: (1) **middle genicular,** piercing the capsule immediately in front of its origin; (2) **superior medial genicular,** and (3) **superior lateral genicular,** each running horizontally and each embracing the femur above a condyle; (4) **inferior medial genicular,** coursing along the upper border of the Popliteus. It is the only one to run obliquely and is below the joint level; (5) **inferior lateral genicular,** running horizontally lateralwards just above the level of the head of the fibula. Notice that the last four let nothing come between them and bone.

THE BACK OF THE THIGH. Remove the deep fascia along the course of the **posterior cutaneous nerve of the thigh.** Turn the nerve up. Clean the **sciatic nerve** and the branches from its medial side to the hamstrings and the one branch from its lateral side to the short head of the Biceps.

All the named arteries encountered here are perforating branches of the profunda. They were dissected with the medial region of the thigh. Clean and separate the hamstring muscles from one another and observe their origins from the ischial tuberosity. Separate the Semimembranosus from the filmy **posterior intermuscular septum** which intervenes between it and the Adductor Magnus.

Clean the **short head of the Biceps** and separate it from the dense **lateral intermuscular septum** between it and the Vastus Lateralis. Trace the tendon of the **Biceps** to its insertion in the head of the fibula. This insertion is split by a fibrous cord, the lateral ligament of the knee, to be studied later.

Now turn to the three fascia-like insertions on the medial side of the knee. The **Sartorius** has been followed already. Behind it, clean right to the bone the slender tendon of the **Gracilis** and behind this, the tendon of the **Semitendinosus.**

Observe the main insertion of the **Semimembranosus** tendon into the back of the medial tibial condyle but disturb neither it nor the well marked expansion it gives to the back of the fibrous capsule, nor the fascial covering it provides for the **Popliteus**, nor the contribution it makes to the medial ligament of the knee.

THE LEG

The bones of the leg are very unequal in size and, whereas the medial surface of the tibia (**medial crural region**) is subcutaneous and, in consequence, has the enveloping deep fascia attached to its anterior and medial borders, the fibula is so deeply placed that the enveloping fascia reaches it by means of **anterior** and **posterior peroneal** (fibular) **septa.** Thus, on the lateral side of the leg there exists a **lateral crural region** containing muscles enclosed between these two septa. Further, the interosseous membrane uniting tibia and fibula separates an **extensor region** in front from a **flexor region** behind. In the flexor region the muscles are disposed in two layers, superficial and deep, and it is between the two that the continuations of the popliteal vessels and medial popliteal nerve are found.

The lateral popliteal nerve passes round the lateral side of the neck of the fibula and, piercing the posterior peroneal septum, divides into, (1) the **musculo-cutaneous nerve** for the lateral crural region and (2) the **anterior tibial nerve** which, piercing the anterior peroneal septum, gains the extensor region. The **anterior tibial artery** reaches its companion nerve by passing forwards between the two bones.

THE ANTERIOR AND MEDIAL CRURAL REGIONS AND THE DORSUM OF THE FOOT. The subject lying on its back, place a block behind the knee. Make a vertical cut through

the skin along the medial surface of the shaft of the tibia close behind the anterior border (fig. VI, L to M). By making this cut over bone, injury to the deep fascia is avoided. Make a cut across the front of the ankle from the medial malleolus laterally to the point of the heel (figs. VI and VII, N to O). Reflect one flap of skin medially to just behind the medial border of the tibia. This is to expose the **long saphenous vein.** Reflect the other flap of skin laterally to a line extending from the head of the fibula to the point of the heel. Cut along the midline of the dorsum of the foot to the webs of the toes (fig. VI, M to P); cut transversely across the foot at the webs of the toes (fig. VI, R to Y) and cut along the midline of each toe (fig. VI). Reflect the skin from the dorsum of the foot to its borders and reflect the skin from the toes.

The first duty of the dissector is, of course, to find the cutaneous veins and the cutaneous nerves. One finger's breadth behind the lateral malleolus, which is readily felt on the lateral side of the ankle joint, and rather more than one finger's breadth below it, find the **sural nerve** and trace it to a digit or digits. In company with the nerve is the **short saphenous vein,** which is to be traced distally to the **dorsal venous arch.** The **long saphenous vein,** already dissected at the knee joint, is to be followed distally also to the dorsal venous arch and, accompanying it, the (long) **saphenous nerve** is to be traced to its termination. The **musculo-cutaneous nerve** (superficial peroneal) becomes superficial at a variable point along the line of the anterior peroneal septum. To find this line, place a finger on the subcutaneous surface of the lateral malleolus and run it upwards to the anterior border of the fibula. Since the nerve passes medially on to the dorsum of the foot, it is safe to work lateral to this line. The nerve, which is flat, outcrops as one or two branches; it is to be traced to its termination. **The medial branch of the anterior**

tibial nerve (deep peroneal) becomes superficial at the proximal end of the first intermetatarsal space and descends on the deep fascia of the space. It is readily found by stroking longitudinally with the seeker down to this deep fascia. The musculo-cutaneous nerve communicates with it and also with the sural nerve. The ultimate pattern of cutaneous supply is variable.

Clear away the remains of the superficial fascia and clean the deep fascia. Observe the expansion the **deep fascia** receives from the tendon of the Biceps. The line of the anterior peroneal septum may be made out as a white line. To demonstrate the fact that the muscles arise from the deep fascia, make a short vertical cut through the fascia just below the lateral tibial condyle, lift the edges of the cut, and see muscle fibers arising. The superior and inferior **extensor retinacula** are thickenings of the deep fascia whose fibers take a transverse direction; their borders may best be made out by inspection. The **superior extensor retinaculum** is a relatively simple band extending across the tendons a little above the ankle joint. The **inferior extensor retinaculum** is Y-shaped and rather more complex. The stem of the Y is fixed to the lateral side of the dorsum of the foot a little in front of the lateral malleolus; one limb passes upwards and medialwards to the tibial malleolus, the other curves across the dorsum of the foot to blend with the plantar fascia. Read an account of these retinacula, and then with the point of the knife define (somewhat artificially) these bands from one bony attachment to the other. As this is being done, the **synovial sheaths** will be opened, so with the handle of the knife or seeker, determine the extent of these sheaths. Define the continuity lateralwards of the "stem" of the inferior extensor retinaculum with the somewhat wide **inferior peroneal retinaculum** which holds the peroneal tendons in place on the side of the

calcaneum. Lift up the tendon of the **Tibialis Anterior,** the most medial tendon in front of the ankle joint, and cut the band behind it. (It is stronger than the band in front of the tendon.) This is done in order to see the loops passing round the Extensors and the Peronei. Once the retinacula have been defined and studied there is no occasion to preserve them any longer.

Make a vertical incision through the **deep fascia** in the lower two-thirds of the leg and observe, (a) proximally it gives origin to muscles, (b) distally it can be lifted off the underlying muscles, (c) medially it is attached to the anterior border of the tibia and (d) laterally it is continuous with the anterior peroneal septum.

Examine the position of the structures crossing the front of the ankle joint. From medial to lateral side they are: **Tibialis Anterior, Extensor Hallucis Longus, anterior tibial vessels** and **nerve,** and **Extensor Digitorum Longus.** The lateral and lower fleshy part of the last is the **Peroneus Tertius.** [Did you observe that the tendons of the extensors are on the sides of the muscles which press against the loops previously examined?] Trace the muscles up to their origins, separating them from one another as far as is feasible. Trace the tendons down to their insertions, not despising the digital extensors, at least one of which should be followed to a dorsal expansion on a toe.

Follow the **anterior tibial artery** and **nerve** proximally on the skeletal plane, and observe that they are crossed in front by one muscle only, the Extensor Hallucis Longus, and that they lie along the lateral border of the Tibialis Anterior. Satisfy yourself that the nerve is a branch of the lateral popliteal nerve, by pulling on the latter behind the head of the fibula. Trace the artery to the point where it comes forward between the interosseous membrane and the neck of the fibula.

After gaining the front of the leg the anterior tibial artery gives off the following branches, some of which may be a little difficult to find unless the subject has been well injected: (1) *anterior recurrent*, found by cutting through the origin of the Tibialis Anterior down to the lateral condyle of the tibia; (2) **muscular,** to adjacent muscles; (3) **medial anterior malleolar,** ramifying over the medial malleolus; (4) **lateral anterior malleolar,** larger than (3) and running towards the lateral malleolus. Look for a vessel coming forwards through the lower part of the interosseous membrane to anastomose with the anterior tibial, usually by means of the lateral anterior malleolar branch. Indeed this **perforating branch** of the **peroneal artery** may be large and entirely replace the dorsalis pedis artery.

The **dorsalis pedis artery** is the continuation of the main artery on the foot. It is accompanied by the medial branch of the anterior tibial nerve and it runs directly towards the first intermetatarsal space where, at the posterior end of the space, it passes into the sole of the foot. Find and clean the artery and nerve, and look for the following branches of the artery: (1) **tarsal,** passing lateralwards deep to the **Extensor Digatorium Brevis,** the fleshy muscle of the dorsum of the foot; (2) **arcuate,** running lateralwards across the bases of the metatarsal bones and providing **dorsal metatarsal arteries** for each intermetatarsal space except the first, where the dorsal pedis itself provides the **first dorsal metatarsal artery** as it plunges plantarwards.

While crossing the talus, the anterior tibial nerve divides into a medial and a lateral branch. The medial branch has been seen already. Establish its continuity. The lateral branch passes deep to, and supplies the **Extensor Digitorum Brevis,** and gives articular twigs to the joints. Trace the nerve and clean the muscle.

THE LATERAL CRURAL REGION. The deep fascia is thickened behind the lateral malleolus and, as the **superior peroneal retinaculum,** it holds the tendons of the Peronei behind that malleolus. Define the upper and lower edges of the retinaculum then divide it vertically; insert the point of the closed forceps upwards between deep fascia and muscle, and, using the forceps to guide the knife, slit the fascia up as high as the head of the fibula. Turn the flaps medially and laterally, thereby opening the compartment and revealing the two **peroneal septa** bounding it. The muscles seen are the **Peroneus Longus** and the **Peroneus Brevis;** the latter is closer to the malleolus. Pick up the tendons of the Peronei and note their synovial sheath and its well-developed meso-tendon. Sever the **inferior peroneal retinaculum.** Trace the tendon of the Peroneus Brevis to its insertion and that of the Longus to the point where it is seen disappearing into the sole. Observe that the common **synovial sheath** of the Peronei bifurcates at the peroneal tubercle on the lateral side of the calcaneum. Determine the extent of the tubular prolongation on each tendon. Separate the two Peronei upwards and notice that the **musculo-cutaneous nerve** lies along the anterior border of the Peroneus Brevis. Insinuate the closed forceps from behind, downwards and forwards along the course of the **lateral popliteal nerve,** in contact with the bone, into the anterior compartment. Cut between the blades, and thereby sever the posterior peroneal septum, Peroneus Longus, anterior peroneal septum and Extensor Digitorum Longus. This will expose the lateral popliteal nerve throughout.

THE BACK OF THE LEG. Carry the skin incision from the medial malleolus to the medial side of the point of the heel, thence transversely across the hindermost part of the under

surface of the heel to the lateral side (fig. VIII, Q to O). The part of the cut under the heel should go right down to bone. Remove the skin from the back of the leg. Follow the **short saphenous vein** from the popliteal fossa to the point where it has already been identified behind the lateral malleolus. Follow the cutaneous branches of the medial and lateral popliteal nerves to where they unite to form the **sural nerve** near the lateral side of the tendo calcaneus, the prominent and powerful tendon behind the ankle joint. Make a vertical cut behind the tendo calcaneus to see the **bursa** (if present) between it and the deep fascia. Remove all superficial fascia and clean the superficial layer of the **deep fascia** which spans the tendo calcaneus. Cut the deep fascia vertically throughout its length and reflect it medially and laterally. Cut across the two bellies of the **Gastrocnemius** well below the point of entrance of their nerves (3″ below the knee). Grasping firmly the lower section of this muscle, strip it forcibly downwards from the underlying tendon of the **Soleus,** and so demonstrate the mode of construction of the tendo calcaneus —the two tendons forming it are applied to each other but are not fused. Follow the thin tendon of the **Plantaris.**

Cut through the **Soleus** about 2″ above the calcaneum. Pass two fingers upwards in front of the Soleus (i.e., between it and the loose intermuscular layer of deep fascia), and so demonstrate its horseshoe-shaped origin. At the same time note the bridge that the origin makes for the posterior tibial vessels and nerve, and free, from the bridge, the fascial tube containing those structures. Then detach the Soleus from its tibial origin and turn it laterally. Observe the fleshy "plume" on its anterior surface. At this time observe too how flail-like the foot becomes when the tendo calcaneus is cut.

Examine the origin of the **Gastrocnemius.** (It would

appear as if the Semimembranosus tendon had forced the medial head of the Gastrocnemius on to the *back* of the femur, while the Biceps tendon—inserted well laterally on the upper end of the fibula—has permitted the lateral head of the Gastrocnemius to remain on the *side.*) Note the **bursa** between the applied (therefore necessarily tendinous) surfaces of Gastrocnemius and Semimembranosus. Raise the medial head and observe that it fuses with the capsule

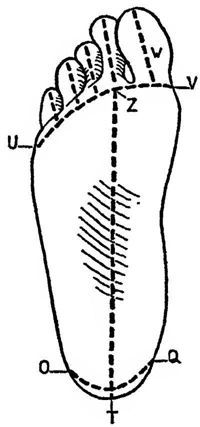

FIG. VIII

of the knee joint; a **bursa** deep to it may communicate with the joint. Trace the lateral head (which may contain a sesamoid bone) and the **Plantaris** to their origins.

Examine the **intermuscular layer of deep fascia.** It lies between the Soleus and the three bipennate flexor muscles which lie deeper. It is loose and does *not* give origin to muscles. Its lower part is the important part of the "anklet" (flexor retinaculum and superior peroneal retinaculum) that binds down the tendons that groove the malleoli. Slit the

layer and reflect it medially and laterally. Note its connection with the posterior peroneal septum laterally, and observe that medially its transverse fibers constitute the bulk of the **flexor retinaculum.** The structures now in view are: (1) the **posterior tibial nerve** and **vessels,** with the large (2) **Flexor Hallucis Longus** lying laterally, and the smaller (3) **Flexor Digitorum Longus** medially. Open the interval between these two muscles and see (4) the **Tibialis Posterior** covered by a fascial sheet, sometimes a mere film, sometimes quite dense.

Clean the **posterior tibial artery** and its companion **posterior tibial nerve** and their branches. Sacrifice the **venae comitantes.** The artery is the continuation of the popliteal and therefore begins at the lower border of the Popliteus muscle. It lies, accompanied by the nerve, successively behind Tibialis Posterior, Flexor Digitorum Longus, tibia and ankle joint. The artery and nerve end behind the medial malleolus by dividing into **medial** and **lateral plantar arteries** and **nerves.** The artery gives off large muscular branches but its largest and most important branch is the **peroneal artery.** This vessel is nearly as large as the parent stem and arises about one inch below the lower border of the Popliteus. Lower down it is found sheltered in the angle between the Flexor Hallucis Longus and the fibula. Behind the lower end of the tibia it is reunited to its parent stem by the **communicating branch** and at about the same level it gives off the **perforating branch** which has already been noted on the dorsum of the foot. Look for the branches of the nerve to the three muscles.

THE SOLE OF THE FOOT

The sole of the foot corresponds to the palm of the hand and, like the hand, has its musculature disposed in layers. Of these the first consists of three muscles which diverge from the

calcaneal tuberosity and, spanning the sole, reach the toes; they act as expansile tie beams for the longitudinal arches. As in the palm, so in the middle of the sole of the foot, there develop, instead of muscle, a thick fascial mass superficially—the **plantar aponeurosis**—and a set of tendons immediately deep to it. In the case of the foot however not only do **Lumbricals** appear in association with the tendons but also another muscle, not present in the hand, the **Flexor Accessorius.** In the depth of the sole there exist two layers, one consists of a special muscle for the great toe—the **Adductor Hallucis,** the other consists of a series of muscles placed between the bones—the **Interossei.**

The medial plantar nerve, accompanied by the medial plantar artery, corresponds to the median nerve in the hand in that, whilst it looks after an extensive cutaneous area ($3\frac{1}{2}$ toes), it devotes most of its motor supply to the muscles of the great toe. The lateral plantar nerve, accompanied by the lateral plantar artery, in order to reach the lateral side of the foot, passes across between layers one and two, and like the ulnar nerve, looks after $1\frac{1}{2}$ toes and the two deep layers.

Lastly, since the foot is arched, joint surfaces between adjacent bones lie more dorsally and the important ligamentous structures occupy the plantar aspect.

At the edge of the skin-cut across the heel note the thickness of the pad of tough fatty tissue on which you walk. Make an incision along the middle of the sole of the foot (fig. VIII, T to Z) and along each toe (fig. VIII, W) and a transverse one at the webs of the toes (fig. VIII, U to V). Remove the skin entirely.

As in the hand, so in the foot, three groups of structures are in danger; therefore attend to them at once:

1. **Medial calcaneal nerve** to the skin of the heel. This

plantar nerve and pierces the flexor retinaculum very close to the calcaneal tuberosity. If the retinaculum is cleaned from above downwards and the main nerve traced, the branch under consideration may be picked up. It may be traced right across the under surface of the heel.

2. **Digital branch of the medial plantar nerve** (and artery) to the medial side of the great toe. A line drawn from the medial side of the calcaneal "tuberosity" past the medial side of the medial sesamoid bone of the great toe will indicate the course. Cut through the fat along the distal part of this line and secure and trace the nerve.

3. **Digital branch of the lateral plantar nerve** (and artery) to the lateral side of the little toe. Their course is indicated by a line from the medial side of the calcaneal "tuberosity" to the head of fifth metatarsal bone. Find the nerve in the distal part of this course and trace it out. Observe that these two marginal digital nerves (and vessels) are covered by a film of deep fascia as well as by the thick fatty superficial fascia. By longitudinal cuts just proximal to the webs of the toes find the remaining digital nerves and vessels.

Starting at the heel and employing both the handle and the point of the knife, peel the superficial fascia off the dense **plantar aponeurosis.** As you work distally you will have to exercise care in defining the slips of the aponeurosis that pass one to each toe and, at the webs of the toes, are united to one another by unimportant and weak transverse bands, the *superficial transverse ligaments of the sole*, which afford some protection to the digital vessels and nerves. Later it will be seen that, here also. the slips straddle the tendons and by passing down on each side to be attached to the **deep transverse ligaments of the sole,** retain the tendons in place. The arrangement is similar to that present in the hand. When the plantar aponeurosis is cleaned, note that it is rendered tense

by dorsi-flexion of the toes. Observe the medial and lateral longitudinal **plantar furrows** along which the plantar aponeurosis sends septa into the depth of the foot. Along the lines of the furrows observe, but do not preserve, the cutaneous twigs of the nerves and arteries which pierce the fascia to supply the skin of the sole.

THE FIRST LAYER OF MUSCLES. The muscle exposed on the medial side is the **Abductor Hallucis** and on the lateral side, the **Abductor Digiti Quinti (Minimi)**. The muscle underlying the aponeurosis is the **Flexor Digitorum Brevis.** Split the dense plantar aponeurosis along the middle of the foot backwards to the calcaneal tuberosity. As you reflect the flaps medially and laterally it will be necessary to dissect off the essential origin of the Flexor Digitorum Brevis from the deep surface of the aponeurosis. When the muscle is free, pass the handle of the knife right across its deep surface, raise it and observe that: (a) it is lying in an oblong fascial box open only in front; (b) it has an insignificant slip of origin from the hinder (bony) part of the box; (c) the sides of the box are the intermuscular septa in the furrows; (d) a sheet of fascia separates it from the deeper muscles; and (e) the nerve enters it on its medial side about one inch from the calcaneal tuberosity.

The **Abductor Hallucis** can be more readily freed from the underlying Flexor Hallucis Brevis if its medial (i.e., upper) border is first cleaned abreast of the navicular tuberosity, this being well behind the posterior limits of the underlying muscle. Free it forwards and backwards. As its lateral (i.e., lower) border is being freed, be careful not to injure the medial plantar vessels and nerve. Trace the Abductor Hallucis to its origin and insertion and leave it intact.

The **Abductor Digiti Quinti.** For a similar reason ap-

proach this muscle abreast of the base of metatarsal V, and clean its lateral border there first. Deep to it at this point will be seen the tendon of the Peroneus Longus. If the cord of aponeurosis attached to the tip of the base of metatarsal V is fleshy, sever it. Free the muscle and leave it also intact.

Remove piecemeal the distal part of the plantar aponeurosis and clean and identify the **tendons** of the Flexor Digitorum Brevis. Find the **communicating branch** between the medial and the lateral plantar nerve. Trace the tendons forwards on the toes and notice that the arrangement of the fibrous and synovial sheaths is the same as that in the hand. Review this arrangement.

Cut the aponeurosis at the heel and then excise a piece of Flexor Digitorum Brevis, so as to expose fully the wide origin of the Abductor Digiti Quinti. The two abductors have a continuous fleshy origin.

Establish the continuity of the plantar vessels and nerves. Trace the medial plantar ones throughout. Trace the lateral plantar ones to the base of metatarsal V where the main stem passes deep. Trace the superficial branches throughout. Immediately in front of the medial tubercle of the calcaneum find the muscular branch of the lateral plantar nerve to the Abductor Digiti Quinti.

The Second Layer of Muscles. It is so important to retain the contour of the foot that you should on no account disturb either Abductor. Reflect only the Flexor Digitorum Brevis; while doing so, it is inadvisable to try to preserve the digital vessels and nerves. Remove entirely the proximal part of the muscle.

The fleshy muscle now exposed in the posterior half of the foot is the **Flexor Accessorius.** Trace it to its insertion in

the tendon of the Flexor Digitorum Longus. Its origin cannot yet be fully investigated. The tendon of the **Flexor Digitorum Longus** divides into four slips for the lateral four toes, and arising from the slips are four delicate **Lumbricales.** Trace the tendons and the Lumbricales to their insertions. Their dispositions in the toes are similar to those in the fingers. Review these dispositions. Observe that the tendon of the Flexor Digitorum Longus crosses superficial to that of the Flexor Hallucis Longus abreast of the navicular tuberosity and that it receives a fibrous slip from the Flexor Hallucis Longus tendon. Lift up the distal part of the tendon of the **Flexor Hallucis Longus** and examine its grooved bed, formed successively by: the Flexor Hallucis Brevis, two sesamoids, and the phalanges. It has a delicate fibrous and a synovial sheath. The continuity of the long flexors will be established later.

The Third Layer of Muscles. Cut across the Flexor Digitorum Longus at the distal limits of the Flexor Accessorius and reflect the two parts. There is no occasion to cut the Flexor Hallucis Longus. In the anterior half of the metatarsal region lie the muscles of the third and fourth layers. Those of the 3rd layer are:

1. The **Flexor Hallucis Brevis,** covering the 1st metatarsal;
2. The **Flexor Digiti Quinti,** covering the 5th metatarsal;
3. The **Adductor Hallucis,** occupying the space between.

The **deep branch of the lateral plantar nerve** (and **artery**) is a guide to the oblique lateral border of the relatively massive **Adductor Hallucis Obliquus,** so follow it to that border. Remove the thin fascia covering these muscles and, at the heads of the metatarsals, look for the slender **Adductor**

Hallucis Transversus—it may be so insignificant as to escape attention. Free the Adductor and the two short flexors, and study their origins and insertions. Trace the deep branch of the lateral plantar nerve (and artery) deep to the Adductor Hallucis. Pass the handle of the knife between the Adductor and the underlying **Interossei**; cut and reflect the Adductor.

Besides cutaneous and muscular branches the **lateral plantar artery** gives off from its arch a series of **plantar metatarsal arteries** which run on the Interossei towards the clefts between the toes; by means of **perforating branches** at the proximal and distal ends of intermetatarsal spaces these vessels reinforce those on the dorsum of the foot. The arrangement is reminiscent of that present in the hand. Clean the **deep plantar arch** and its branches and observe the dorsalis pedis artery completing it medially by passing into the sole at the proximal end of the first interosseous space.

The Fourth Layer of Muscles. These are the **Interossei** and they appear as a compact muscle mass. They are to be separated into their units. The axis of the hand passes through the third metacarpal, but in the foot the axis passes through the second metatarsal. **Plantar Interossei** are arranged to approximate the toes to this axis; **Dorsal Interossei,** to separate them from this axis. Actually these actions are little required in the foot but an understanding of this primitive arrangement leads to an appreciation of where exactly each tendon passes to a **dorsal expansion** of an **extensor tendon.** The details of this extensor expansion need not delay the student since it is similar to that already studied on the hand but not nearly so important. Carry the knife from the **plantar ligament** or plate (cf. palmar ligament or plate) underlying the head of metararsal V proximally along the

shaft of the bone. This opens the space between the Flexor Digiti Quinti and the 3rd Plantar Interosseous. Similar cuts along the metatarsals separate the muscles as follows: along IV, 4th Dorsal Interosseous from 2nd Plantar; along III, 3rd Dorsal Interosseous from 1st Plantar; and along II, 2nd Dorsal Interosseous from 1st Dorsal.

On holding two adjacent toes widely apart, the knife may be inserted between them; the **deep transverse ligaments of the sole** may be cut; and the *bursae* between adjacent metatarsal heads observed. These ligaments join the margins of the **plantar ligaments** or plates protecting the metatarsophalangeal joints, and are similar to the palmar ligaments in front of the metacarpal heads (q.v.). Cutting them permits the Interossei to be followed more fully and makes for a neat dissection. Notice that the vessels, nerves and Lumbricals cross to the toes on the plantar side of the transverse ligaments whilst the Interossei cross on the dorsal side.

THE MEDIAL SIDE OF THE ANKLE. Reflect the flexor retinaculum and the origin of the Abductor Hallucis from the calcaneum. Find the **nerve to the Abductor Hallucis** and then clean the nerves and vessels entering the foot. Displace the nerves and vessels medially and slit the tunnel in which the Flexor Hallucis Longus runs. Clean the **Flexor Digitorum Accessorius;** it arises from the concave medial surface of the calcaneum. An insignificant slip arises also from the lateral border of the calcaneum.

Identify the **sustentaculum tali.** It is the ledge of bone projecting medially from the calcaneum an inch below the medial malleolus. Observe that the Flexor Hallucis Longus passes below the ledge (and so uses it as a pulley); the Flexor Digitorum Longus passes along the medial border of the ledge; the Tibialis Posterior passes above the ledge. Trace

the **Flexor Hallucis Longus** and the **Flexor Digitorum Longus** in their continuity. Leave the insertions of the Tibialis Posterior and Peroneus Longus until the joints of the foot are dissected.

THE JOINTS

The objective in dissecting ligaments and capsules is to reveal those that, having strength, act as restraining bands or bonds of union between two bones. If the parts have become dry, it is well at this stage to use fluid, a few drops of water, to restore their suppleness and render them pliable again. Ligaments, when exposed, should be stroked along the course of their fibers with the point of the knife. This, by removing areolar tissue, renders their directions obvious. The exact sites of attachment must be defined by removing the surrounding periosteum and soft tissue with the squared handle of the scalpel. It is a common fault to leave the attachments and edges of ligaments undefined.

The Hip Joint: Cut long the origins of the Sartorius, Rectus Femoris and Pectineus. This is a suitable time to review the origins of these three muscles. Reflect these muscles, but leave the Ilio-psoas intact in front of the joint. Trace the tendinous insertion of the Psoas to the lesser trochanter, and the fleshy insertion of the Iliacus into the psoas tendon and into the femur for ½″ below the Psoas insertion. Note the positions of the femoral nerve, artery and vein in especial reference to the psoas tendon. The fibrous capsule of the joint is visible medially and laterally. With the knee extended and the ankle dorsi-flexed, the limb becomes a rigid column. Put the limb in this position, grasp the foot (as you would grasp the handle of a walking-stick), rotate the limb and feel the head of the femur through the capsule on each side of the Ilio-psoas rotating too. Flex the

hip, in order to relax the Ilio-psoas; divide the Ilio-psoas and the femoral vessels and nerve; throw them up and see the **psoas bursa** deep to the psoas tendon. Observe: (a) that the tendon plays in the groove between the ilio-pubic eminence and the anterior inferior iliac spine, and (b) whether the bursa has established a communication with the joint.

Moisten the capsule with water, if necessary, to revive it. Identify the **ilio-femoral ligament:** it is the exceedingly strong, triangular, anterior portion of the capsular ligament, whose apex is attached to the anterior inferior iliac spine and whose base occupies (and is responsible for) the trochanteric line. Clean the ligament by stroking it downwards with the point of the knife; define carefully its borders. The much thinner medial part of the capsular ligament is the **pubo-femoral ligament.** Clean it also and observe that it is between these two ligaments that the capsule is thinnest and the psoas bursa may communicate with the joint cavity If no communication already exists, open the joint by a one inch vertical incision along the line where the psoas tendon lay. Inside the capsule you can now see an extensive (articular) area of the head of the femur facing forwards—of course, this is not true if the limb is rotated medially. At this stage define the origin of the **Obturator Externus** and examine the **obturator nerve** entering the thigh.

Turn the subject on to the face and re-examine the posterior relations of the joint. Cut the Piriformis, Gemelli and Quadratus Femoris. The Obturator Internus tendon has already been cut, as have also the Glutei Maximus et Medius. Clean, cut, and reflect the Gluteus Minimus (i.e. the immediate lateral relation of the joint). Observe the bare triangular area on the back of the neck of the femur on which the tendon of the Obturator Externus plays. Here the synovial capsule projects and acts as a bursa for the ten-

don. Clean the posterior portion of the fibrous capsule, the **ischio-femoral ligament.** Its fibers are not well defined, but they take a direction parallel to the tendon of the Obturator Externus. Note that the ligament, which is the posterior part of the fibrous capsule, is taut on medial rotation. Rotate the limb laterally, thereby rendering the posterior part of the capsule lax, and by palpation determine the location of the obliquely set acetabular margin. Open the joint by incising the capsule a little above the tendon of the Obturator Externus; insert the closed forceps and with them explore the lower limits of the synovial capsule. By a vertical incision sever the lower band of fibers and observe that, except in medial rotation, no part of the articular head is visible from behind.

Dislocation of the Hip. Considerable force is required to accomplish this dislocation and if you are not sure what you are about seek the advice of a demonstrator. Restore the sciatic nerve to its position, noticing that it crosses the obliquely set acetabular margin. With the subject on the face and the pelvis at the end of the table let the limb hang over the end of the table. Turn the toes forcibly medialwards and at the same time flex the hip joint still further. Your partner must steady the pelvis. Persist in this manoeuvre until the **ligament of the head of the femur** ruptures and the head passes out of the acetabulum on to the dorsum of the ilium.

Cut across the Quadratus Femoris and view the socket for the femoral head. This is half a hollow sphere, a broad horseshoe-shaped area of which is lined with articular cartilage. Below however a ligament stretches between the two limbs of the horseshoe. This is the **transverse ligament** of the acetabulum and it too is articular. A fibro-cartilaginous rim, or **labrum,** extends all round the periphery and serves to deepen the socket. Examine these features and then pass

the point of a seeker through the **acetabular notch** deep to the transverse ligament and so into the non-articular **acetabular fossa.** Demonstrate two points: (1) the seeker can be swung round extra-synovially in the fat occupying the acetabular fossa: (2) it can be made to pass still extra-synovially up the (torn) hollow synovial cone whose apex is implanted on the fovea of the femoral head. Within this collapsed cone lies a weak ligament, the **ligament of the head of the femur,** whose acetabular attachments are the margins of the acetabular notch and the transverse ligament. Arteries take advantage of this route to reach the fat and the head of the femur.

Turn the subject on to the back. Observe that the ilio-femoral ligament is still intact in spite of the dislocation. Feel the great thickness of its lateral band. Reduce the dislocation as follows, observing the effect of each movement on the ilio-femoral ligament and on the head of the femur, and why the sequence of movements brings about the desired result: Flex the thigh fully and adduct it; circumduct it into the abducted position, then extend it.

Turn to the femur and notice the extent to which the **synovial membrane** covers the front and back of the neck. Note the ridges on the neck (cervical retinacula) covering arteries. The synovial membrane can be stripped off the back of the neck and where it ends (at the periphery of the head) the cartilage begins.

THE KNEE JOINT. Above the knee, cut across the Sartorius, Gracilis and Semitendinosus and turn them aside. Clean the deep fascia from the front and sides of the knee. The **ilio-tibial band** or tract is about an inch wide; clean it by stroking along the course of its fibers with the point of the knife, and note it is attached to the lateral side of the patella

and to the lateral tibial condyle. In cleaning it, you will remove a thin superficial layer of circular fibers; another such layer may be seen on its deep surface. In the same manner define the superficial part of the **medial ligament** of the knee. Note its attachments and relations. Cut the superficial band-like part of the ligament below the medial tibial condyle where it bridges the medial inferior genicular vessels and nerve, and dissect it up to the medial femoral epicondyle. This exposes the deeper deltoid portion of the ligament; clean it. Now define the cord-like **lateral ligament** and cut the Biceps, but do not cut the ligament. Puncture the small **(Biceps) bursa** between the ligament and the Biceps, and re-examine the insertion of the Biceps.

Define the **expansions of the Vasti** and the **ligamentum patellae.** Make a wide horseshoe-shaped incision through the Vasti from epicondyle to epicondyle rising 3″ above the patella. The incision must be wide of the suprapatellar (Quadriceps) bursa and must cut the ilio-tibial band as well as the Vasti. Identify the **Articularis Genu** (i.e., deep fibers of Vastus Intermedius inserted into the summit of the synovial capsule). Dissect the Articularis Genu off the femur and clean the front of the bone, reflecting the **synovial capsule** until the line of its attachment from epicondyle to epicondyle is encountered. If you have difficulty in defining this line, make a transverse cut immediately above the patella into the joint cavity and with the knife handle explore its upper limits. The sac-like recess is the **suprapatellar** or **Quadriceps bursa.**

Turning to the back of the joint, sever and displace the vessels and nerves. If not already done, free the Plantaris and both heads of the Gastrocnemius from the capsule, noting the bursa deep to the medial head. Cut the Semimembranosus two inches above the joint and see the **(Semi-**

membranosus) **bursa** deep to its tendon. At the back of the capsule, define the **oblique ligament** passing from the Semimembranosus tendon obliquely upwards and lateralwards, parallel to the upper border of the Popliteus. Cut through the fleshy fibers of the Popliteus, raise its tendon and follow it to the femur. In doing this, you will open the **Popliteus bursa** deep to its tendon and communicating with the joint. As the tendon of the Popliteus is followed to the femur, you will see the **lateral semilunar cartilage** of the knee and the **inferior lateral genicular artery** coursing on its side.

Clear away any fat encountered on the back of the capsule, and, in the region of the posterior notch of the tibia between the two condyles, remove enough of the back of the capsule to expose the tibial attachment of the **posterior cruciate ligament.** Clean this ligament from below upwards and observe, if present, a slip of ligament joining it from the lateral semilunar cartilage. Open into the joint behind each femoral condyle by vertical and transverse cuts and explore with a seeker the attachments of the synovial capsule. Satisfy yourself that the cruciate ligaments are entirely outside the synovial capsule.

Turn to the front of the joint and open it by a transverse incision just above the patella (if not already done). After inserting a probe to determine the line of synovial reflexion on the femur, carry the incision round the sides and back of the joint.

The two halves of the joint were originally two independent joint cavities separated by an **'intercondylar septum'**; this septum partially broke down in front and, save for the connexion thus established whose position and size should be carefully noted, the two cavities are still independent. Examine the septum in front represented by a synovial fold, the **infrapatellar fold** (lig. mucosum); the lateral free margins of

the fold are the **alar folds** and a pad of fat occupies its base. At the back of the joint the 'intercondylar septum' is complete and is represented by the **cruciate ligaments** and the **synovial capsule** which passes round them, so as to exclude them from the interior of the joint cavity. Read an account of this septum.

After snipping through the infrapatellar fold, the femur and tibia remain attached to one another only by the cruciate ligaments and the lateral ligament of the knee. Rotate the femur medially, noting that the lateral ligament becomes taut and stops the movement. Sever it, and note that medial rotation is now free and results in untwisting of the **cruciate ligaments.** They must be cleaned and studied.

To demonstrate the normal rotation of the knee, hold the leg vertically with the foot resting on the table and let the thigh rest in the open palm of the other hand, the knee joint being flexed. As the thigh is made to pass from flexion to extension, the terminal medial rotation (screw-home movement) of the femur is easily observed. It occurs round the anterior cruciate ligament as a pivot and the ligament becomes progressively more and more taut until finally, at full extension, it prohibits further rotation. Observe that in full extension the ligament occupies a subsidiary notch in the intercondylar notch.

Pass the handle of the knife below the semilunar cartilages, approaching them from their free, thin, concave borders, and compare the lengths of the **coronary ligaments** attaching them to the tibia. That on the lateral side is considerably the longer, consequently movement of the lateral semilunar cartilage is a great deal freer than movement of the medial which, indeed, is practically immobile. Cut these ligaments horizontally and define the line of reflexion of the synovial capsule to the tibia ($\frac{1}{4}''$ from upper border). Sever the anter-

ior cruciate ligament and determine the function of the posterior one. On no account sever the posterior cruciate ligament, but re-examine the attachments of these ligaments to femur and tibia, and note the *transverse ligament* of the knee joining the anterior margin of the lateral semilunar cartilage to the anterior end of the medial one. Lastly, after noting that their attached ends or 'horns' are ligamentous, contrast the two semilunar cartilages, for their structural differences are reflected in, or reflect, their not inconsiderable functional differences.

THE ANKLE JOINT. Review the relations of the tendons and vessels. Cut and reflect the structures crossing the front of the joint, with the exception of the Tibialis Anterior. At the medial side cut only the Flexor Digitorum Longus. Do this well above the joint and reflect it off the **deltoid** (i.e. **medial**) **ligament of the ankle** and off the side of the sustentaculum tali, along which it runs and which it renders smooth. Displace forwards the Tibialis Posterior and then define and clean the deltoid ligament. It is in two parts: (1) a strong superficial band passing downwards and backwards to the sustentaculum tali—the *calcaneo-tibial ligament;* (2) a deep fan-shaped portion spreading out to the medial side of the talus. Notice that the anterior part of this deep portion is weak and reaches the navicular; the posterior part is strong and reaches the medial tubercle of the talus.

On the lateral side displace forwards the Peronei, observing the mesotendons associated with their synovial sheaths. (The upper and lower retinacula have been severed.) The names of the ligaments now to be cleaned sufficiently proclaim their situations. Define the cord-like **calcaneo-fibular ligament** and weak **anterior** and strong **posterior talo-fibular ligaments.** These three, in effect, comprise the lateral ligament of the ankle

joint. Posteriorly a relatively long ligamentous band unites the tibia and fibula below the level of the inferior tibio-fibular joint. This is the **transverse tibio-fibular ligament** and it occupies nearly the whole extent of the posterior edge of the inferior surface of the tibia. The ligament continuous with it above will be noted in a moment, but observe now that the transverse tibio-fibular ligament deepens the socket for the talus and is articular; a little triangular facet, giving the appearance of bone worn away, being present where this ligament rubs on the back of the talus.

Plantar-flex the ankle and incise transversely the **synovial capsule** between the medial and lateral ligaments. With the handle of the knife explore the forward extension of the synovial capsule on to the neck of the talus. Dorsiflex the ankle and appreciate the reason for this forward extension. The posterior part of the capsule was largely opened when the posterior talo-fibular ligament was defined. (Indeed, the posterior talo-calcanean joint lying just below was probably opened at the same time.) In order fully to display the articular parts of the ankle joint, sever the three lateral ligaments and dislocate the foot by swinging it medially; the medial ligament, which remains intact, acts as a hinge. Pass the handle of the knife, or a thin piece of stick, upwards between tibia and fibula and explore the extent of the prolongation of the joint cavity upwards between tibia and fibula. The Peronei may now be cut in order to investigate the joints of the foot.

THE TIBIO-FIBULAR JOINTS. Remove the uppermost fibers of the Extensor Digitorum Longus and Peroneus Longus. The Popliteus tendon has already been divided and reflected. Strip the remains of the six muscles from the front and back of the interosseous membrane. Observe the

two arteries related to the inferior tibio-fibular joint, one in front of it and one behind it. What is their source?

Notice that the **superior tibio-fibular joint** is found on the postero-lateral aspect of the lateral tibial condyle. It occasionally communicates with the knee joint via the bursa deep to the tendon of the Popliteus. Clean its strong anterior and weak posterior fibres and by opening into it satisfy yourself that it is a synovial joint. The **intermediate** and **inferior tibio-fibular joints** are syndesmoses or fibrous joints.

Clean the anterior and posterior ligaments of the **inferior tibio-fibular joint**. Satisfy yourself that these are strong oblique bands. The **transverse tibio-fibular ligament** has been cleaned already. Grasp the leg bones well above the ankle and, by alternately squeezing them together and relaxing the grasp, note the yielding of the inferior joint. Observe the fibular malleolus can be forced upwards and laterally. The common directions of the ligamentous connections allow this. Sever all connections between tibia and fibula except the interosseous membrane; test its strength and observe the direction of its fibers. Examine the triangular area of syndesmosis and the strip of cartilage below this area, both on the tibia and the fibula.

THE JOINTS OF THE FOOT. The dissector should work with an articulated skeleton of the foot beside him and identify on it the bones and joint surfaces with which he is immediately concerned. Since two joints exist between the talus and the calcaneum they necessarily move reciprocally. They are the TALO-CALCANEAL JOINT and the TALO-CALCANEO-NAVICULAR JOINT which latter, as its name implies, involves a third bone. These two joints are best dissected together.

Replace the talus in the ankle socket thus rendering it immobile and manipulate the underlying calcaneum, when it

will be apparent that the considerable amount of movement demonstrable occurs round an axis which unites the talus and calcaneum between the two joints. This axis or pivot is the very strong **interosseous talo-calcaneal ligament,** and it occupies the region known as the sinus tarsi; identify this sinus and locate the ligament.

Remember that any ligament that passes from tibial or fibular malleolus to the calcaneum will influence the talo-calcaneal joint as well as the ankle joint. The calcaneo-fibular ligament has been cut already; cut now the insignificant *lateral talo-calcaneal ligament,* which lies immediately in front of, parallel to, and deep to the calcaneo-fibular ligament. Cut the posterior part of the talo-calcaneal capsule, then the dorsal part of the talo-navicular capsule and any insignificant bands associated with it. It only remains to cut the strong interosseous talo-calcaneal ligament to permit you, if the talus is still in its ankle socket, to swing the calcaneum medially and with it the remainder of the foot, using the deltoid ligament as a hinge.

After observing the attachments of the (cut) interosseous talo-calcaneal ligament turn to the socket for the head of the talus. Three bony surfaces and three ligamentous ones comprise it. The bony surfaces are:

1. **Middle calcaneal facet,** on the upper surface of the sustentaculum tali.
2. **Anterior calcaneal facet,** on the upper surface of the extreme antero-medial corner of the body of the calcaneum. This may be continuous with 1. or separated from it by a fibrous but articular band.
3. Posterior articular surface of the navicular.

The ligamentous surfaces are:

1. The strong **plantar calcaneo-navicular ("spring") ligament,** extending from the full length of the sustentaculum

tali to the navicular bone between the tuberosity and the angle. It is fibro-cartilaginous where squeezed between the head of the talus and the Tibialis Posterior but ligamentous and pliable elsewhere.

2. The **deltoid ligament,** attached to the spring ligament and completing the socket medially.
3. The medial limb of the **bifurcate ligament,** completing the socket laterally.

The socket for the head of the talus is of such importance to the integrity of the foot, since it occupies the position of the 'keystone' of the high medial arch, that the structures comprising it should be carefully studied. Of these the bifurcate ligament is least important. It will be found on the upper surface of the calcaneum lateral to the anterior calcaneal facet, and it runs to the contiguous parts of the navicular and cuboid. Besides completing the socket laterally it serves to separate this joint from the calcaneo-cuboid.

THE CALCANEO-CUBOID JOINT. Define the narrow incomplete dorsal band of the capsule, the **dorsal calcaneo-cuboid ligament.** The **medial calcaneo-cuboid** is the lateral limb of the bifurcate ligament; it must be cut. The dorsal band and the strong medial limb of the bifurcate ligament also must be cut. Plantar-flex the cuboid and study the joint surfaces, noting that the calcaneum is rounded medially and that the calcanean angle of the cuboid underlies it.

Clean away the muscles on the plantar aspect of the hinder half of the foot in order to expose the **long plantar ligament.** It runs from the length of the plantar surface of the calcaneum to the ridge behind the groove on the cuboid bone. Superficial fibres from it then bridge the groove to form a tunnel for the tendon of the Peroneus Longus, by passing forwards as three or more slips to the bases of the lateral metatarsal

bones. Reflect the long plantar ligament by severing it in its middle and turning it forwards and backwards, thereby exposing the **short plantar ligament** which is, in effect, the thickened capsular fibres of the calcaneo-cuboid joint. Clean it and the **spring ligament** (from the plantar aspect) and observe carefully that the two ligaments form a continuous layer whose fibers take a common direction forwards and medialwards right across the foot, from the anterior part of the sustentaculum tali to the anterior tubercle of the calcaneum. Manipulate the foot and observe the actions that render the combined ligament taut.

The tendon of the **Peroneus Longus** can now be followed to its insertion. Trace the tendon of the **Tibialis Posterior** to the tuberosity of the navicular, to the small tarsals and to the metatarsals, and notice how important it is in taking strain off the spring ligament.

THE JOINTS OF THE FOOT DISTAL TO THE MIDTARSAL JOINT. **The Intertarsal, Tarso-metatarsal** and **Inter-metatarsal Joints.** Observe the direction of the dorsal bands of the **cuneo-navicular joint** by cutting through them, and open the joint. Carry the incision to the **cubo-navicular joint.** Is this continuous with the cuneo-navicular joint in your particular foot? Explore the extent of the joint and its continuity forwards as **intercuneiform** and **cuneo-cuboid joints.** By manipulation determine the direction taken by the **interosseous ligaments** and note particularly that they take the same direction as the dorsal ligaments; then cut them. Note the **bursa** deep to the insertion of the Tibialis Anterior and communicating with the **first cuneo-metatarsal joint.** Open this joint from above, leaving the plantar ligaments intact to act as a hinge. Observe that it is relatively large and an independent joint whose articular surfaces are kidney-shaped. Then cut the very strong band, **Lisfranc's**

ligament, between the 1st cuneiform and the 2nd metatarsal. Similarly, open the **inter-metatarsal joints** by dividing the inter-metatarsal ligaments. Open the **cubo-metatarsal** joint.

Study now the bases of the metatarsals and the joints opened. The interosseous ligaments should all be severed so that the bones are held merely by their plantar attachments.

The Metatarso-Phalangeal and Interphalangeal Joints are like the corresponding joints in the hand and should be investigated similarly.

Identify the **plantar ligaments (plates)** of the metatarso-phalangeal joints and observe the two sesamoid bones beneath the head of the first metatarsal. The **deep transverse ligaments of the sole,** connecting the edges of the plates to one another, have been severed, but the **collateral ligaments** are still intact and should be cleaned. Notice particularly: (a) their eccentric attachments to the sides of the heads of the metatarsals and (b) fibers radiating from them to the sides of the plantar plates. Lastly examine an interphalangeal joint and observe that, while it possesses a plantar ligament and collateral ligaments, the shapes of the bones concerned in the joint preclude any abduction or adduction; the interphalangeal joints are, therefore, hinge joints.

CHAPTER V

THE THORAX

THE THORACIC WALL. Before beginning its dissection the student should familiarize himself with the bony architecture of the thorax. He should procure a typical thoracic vertebra, a typical rib and a sternum and make out the following features:

A typical thoracic vertebra consists of a weight-bearing cylindrical block, the **body,** and a protective **neural arch** which is made up of two stout rounded **pedicles** springing from the body nearer its upper than its lower surface and connected to one another by two flat plates or **laminae.** At the junction of pedicle and lamina there project: laterally a **transverse process;** superiorly and inferiorly an **articular process.** At the junction of the two laminae there projects posteriorly a medianly disposed **spinous process.**

A typical rib consists of a **head, neck** (often with a sharp-edged bony flange projecting upwards from it), and **shaft.** On the back of the rib where neck meets shaft is a pronounced **tubercle,** and where the shaft reaches its most backward sweep is the **angle.** The upper border of a rib shaft is rounded but the lower border is sharp and flange-like to shelter a **costal groove** for the accommodation of intercostal vein, artery and nerve.

The sternum consists of a relatively wide upper segment the **manubrium,** a **body** made up of four easily distinguishable segments or *sternebrae* and a pointed lower extremity, cartilaginous till middle life, the **xiphoid process.**

By reference to an articulated skeleton the following additional facts should be verified:

1. Two adjacent vertebral bodies are united by a fibrocartilaginous **intervertebral disc.** This is a cartilaginous joint.
2. Two adjacent neural arches are united by their articular processes. These are paired synovial (arthrodial) joints.
3. An **intervertebral foramen,** for the exit of a spinal nerve, is completed when two adjacent vertebrae are in position and is bounded above and below by pedicles, in front by the cartilaginous joint, and behind by the synovial joint.
4. A rib head articulates typically with two vertebral bodies and the intervening disc.
5. A rib tubercle articulates with a facet near the tip of the transverse process of the lower of the two vertebrae with which its head articulates.
6. The anterior extremity of a rib is connected to the sternum by means of a bar of hyaline cartilage. These **costal cartilages** become progressively longer from manubrium to xiphoid. Ribs 11 and 12 have free cartilage-tipped anterior ends. Costal cartilages 8, 9 and 10, reach in each case only as far as the cartilage next above.

Before the dissection of an intercostal space can be undertaken, certain large and widespread muscles belonging to the upper limb and to the abdominal wall, and arising in part from the outer surface of the thoracic wall, must be removed. These are Pectoralis Major, Pectoralis Minor, Serratus Anterior, Latissimus Dorsi and Obliquus Externus. Trapezius and Rhomboids, arising from spinous processes, also in part cover the wall and should be removed.

Re-examine now whatever remains of the Serrati Poster-

iores, for they properly belong to the thoracic musculature. **Serratus Posterior Superior,** of paper-like thinness, is more aponeurotic than muscular and lying deep to Rhomboids, runs infero-laterally from the lower cervical and upper thoracic spines to the 2nd to 5th ribs beyond their angles. **Serratus Posterior Inferior,** somewhat larger and thicker, lies deep to Latissimus Dorsi, and runs supero-laterally from the lumbar fascia to the lower 4 ribs also beyond their angles. Do not delay over these unimportant muscles.

The intrinsic musculature of the back occupies the territory between spinous processes and the rib angles. The thoracic wall cannot satisfactorily be dissected while this musculature remains in place. Therefore it is assumed that this musculature has already been dissected and studied. Clear it away completely between the levels of the 2nd to 10th thoracic vertebrae leaving the backs of the laminae exposed. In doing this the dissector must be on the watch to preserve two series of structures: 1. the **posterior rami** of the **thoracic nerves,** many of which have already been seen piercing Trapezius close to the spinous processes. Their cut ends may now readily be found emerging from the depths at the lower borders of the roots of the transverse processes; 2. the small triangular **Levatores Costarum** arising in each case from the tip of a transverse process and fanning infero-laterally to the back of the rib next below. These muscles belong to the thoracic wall and each is but the hindermost portion of the **External Intercostal** muscle now to be dissected.

The Intercostal Muscles, like the muscles of the abdominal wall, occupy three planes, though it is probable that only two planes will be satisfactorily displayed. The outer and intermediate planes may readily be separated from one another since a minimal amount of areolar tissue intervenes and since the fibres of the muscles forming the two planes lie at right angles to one another.

With these facts in mind choose the second intercostal space and identify between the costal cartilages bounding it, the thin **anterior intercostal membrane.** This is the "aponeurosis" of the **External Intercostal** muscle whose fleshy fibres do not extend forwards beyond the end of the rib proper. Cut the membrane along the line of its attachment to the lower border of the cartilage and insert the rounded flat handle of the knife deep to it and push the handle backwards into the areolar tissue deep to the External Intercostal. With the handle as a guide cut the muscle inch by inch from the rib above turning it down as you proceed. Observe the muscle becoming progressively thicker. As the mid-lateral line is approached be careful not to destroy the **lateral cutaneous branch of the intercostal nerve.** It pierces the muscle and should be freed and preserved for, later, its origin from the main stem is to be seen. When the muscle has been turned down as far back as the Levator Costae detach this latter muscle from its origin and turn it down also. This will gain room to expose the **superior (anterior) costo-transverse ligament.** This ligament lies medial to the Levator Costae and on a deeper plane. It is a thin rectangular ligament less than an inch wide running nearly vertically from the transverse process to the neck of the rib next below. It is the presence of this ligament that accounts for the flange on the neck of the rib. Clean the posterior surface of the ligament and observe both the direction of its fibres and its continuity laterally with the thin **posterior intercostal membrane.** This membrane is the "aponeurosis" of the more superficial plane of the **Internal Intercostal** muscle. Immediately in front of the ligament and membrane lies the **anterior ramus** of the second thoracic nerve.

At this point it is desirable to investigate the manner in which a rib is united to the numerically corresponding transverse process. The structures concerned are two

ligaments with a little joint cavity between them. Filling the interval between the back of the neck of the rib and the front of the transverse process with which the rib articulates is the **ligament of the neck.** It is quite inaccessible, but its presence and situation should be understood. Lateral to this ligament lies a little joint between rib tubercle and transverse process. Leave it intact but manipulate the rib to demonstrate its existence and the existence also of the short but strong **ligament of the tubercle** which runs horizontally lateralwards from the tip of the transverse process to the non-articular portion of the rib tubercle. Clean this readily accessible ligament with strokes of the tip of the knife.

The **radiate ligament** which binds the head of a rib to two vertebral bodies and their intervening disc cannot be seen at this stage.

After the joint and ligaments have been studied pick up the **intercostal nerve** where it is visible lateral to the superior costo-transverse ligament. Trace the nerve medially to its junction with the **posterior ramus** already identified, being careful not to injure the subjacent thin and delicate **pleura.** In order to demonstrate this junction it is usually not necessary to cut the superior costo-transverse ligament. Observe that the posterior ramus passes backwards on the medial side of the superior costo-transverse ligament. Next trace the intercostal nerve laterally as it rises to seek the shelter of the rib above accompanied by the companion artery and vein. Soon some muscle fibres intervene between nerve and pleura. These represent the deeper plane of the Internal Intercostal muscle.

Free the nerve from the **costal groove** and, by following it forwards, the space between the two planes of the Internal Intercostal is opened up. In actuality *at the back of the space*

the nerve appears to be immediately deep to the External Intercostal so thin is the posterior intercostal membrane; *at the mid point of the space*, i.e. the mid-lateral line where it gives off its lateral cutaneous branch, the nerve appears to run in the substance of the Internal Intercostal; *at the front of the space* the nerve appears to lie deep to the Internal Intercostal with very little intervening between it and pleura.

Just before the upper 6 nerves reach the margin of the sternum they cross in front of the **internal mammary artery** and **vein** which descend on the inner surface of the thoracic wall a finger's breadth lateral to the sternal margin. The nerves, by this time quite small, then turn forwards through everything in their path to reach the skin. They will be found only in those spaces in which the branch of the artery accompanying them has been successfully injected and so indicates their sites.

Clean the section of internal mammary artery in the space and establish its relation to the nerve. Endeavour to find two branches passing into the space, the **anterior intercostal arteries.** The upper one is usually the larger, though both are small, and it lies under shelter of the rib, above its companion nerve and below its companion vein; its course is similar to that of the nerve. The two vessels anastomose with the two divisions of the single **aortic intercostal artery** which accompanies the nerve in the posterior portion of the space. You will make out these features only with difficulty unless the subject has been very successfully injected. The nerves of the thoracic wall and of the abdominal wall lie in the same plane, i.e., between the two portions of the Internal Intercostal in the one case, and between Internal Oblique and Transversus Abdominis in the other. The anterior rami of the lower six thoracic nerves enter the abdominal wall.

In order to attain this, nerves 7, 8 and 9 pass behind costal cartilages and pierce the origin of the Diaphragm; nerves 10 and 11, being concerned with spaces whose anterior ends are open, need concern themselves with no cartilages, whilst nerve 12 is not intercostal but subcostal. Verify these facts in the case of nerve 8 by dissecting the 8th space. This will give you an opportunity also to pay especial attention to those details you did not demonstrate to your satisfaction when you dissected the 2nd space. Remember that the fibres of the Diaphragm arising from just within the lower margin of the costal cartilage take a marked upward sweep, therefore the Diaphragm lies very close to the thoracic wall and neither it nor the pleura should be injured.

Proceed to remove costal cartilages 2 to 6 in the following manner: [Costal cartilages 1 and 7 are to be left intact in order that the position of the sternum shall be maintained.] Each costal cartilage is enveloped in **perichondrium.** Demonstrate this by making an incision lengthwise along a cartilage and raising the perichondrium with the squared handle of the knife. A sharp knife easily cuts through hyaline cartilage, therefore, taking care not to injure the subjacent pleura, cut cartilages 2 to 6 half an inch lateral to their junctions with the sternum and again close to their attachments to ribs. These cartilages are separated from the pleura by the fibres of the **Sterno-costalis** (Transversus Thoracis), a muscle radiating from the lower part of the back of the sternum to these 5 costal cartilages. It must be cut from the cartilages before they can be freed.

The **internal mammary artery** now fully exposed can be further investigated. It is accompanied by one or two veins. Follow the artery upward on the pleura to its origin from the **subclavian artery.** Follow the artery downwards on the Sterno-costalis to the 6th or 7th costal cartilage where it

divides into **superior epigastric** and **musculo-phrenic arteries.** The former enters the Rectus sheath, the latter skirts along the slit-like space close to the costal origin of the **Diaphragm** and supplies branches to intercostal spaces 7, 8 and 9.

With care and patience ease the pleura away from the ribs by gentle pressure of the finger tips and judicious use of the knife-handle. When this has progressed backwards beyond the angles of the ribs saw through ribs 2 to 6 at their angles. It is well to tuck a piece of cloth round the sawn ends of the ribs as you proceed because ragged rib-ends are very liable to tear the hand. Carry out these procedures on both sides and remove the free portions of the ribs.

Clean the anterior surface of a **sterno-chondral joint** in order to expose the **radiate ligament** fanning out from the medial end of a costal cartilage to the front of the sternum. Next open the joint cavity which this ligament protects and observe the **intra-articular ligament.** At this time also examine one of the **inter-chondral joints.** These exist where one of the lower cartilages—perhaps the 8th—expands somewhere along its length to abut the rib above. Satisfy yourself by opening it that here a synovial joint is present.

The student should now read in his text-book a more detailed account of: (1) the bony thorax including the costal arches and their articulations; (2) the mechanism of respiration; and (3) the intercostal spaces.

The Pleura. Before the dissection proceeds any further it will repay the student to know a few fundamental facts about the pleura. The pleurae are two completely enclosed serous sacs, each of which lines both its own half of the inner surface of the thoracic wall and one lung. Each pleural sac, therefore, like the peritoneum, consists of two layers—**parietal** and **visceral**—continuous with one another at the

root of the lung where that structure invaginated the closed sac from its medial aspect. It has been found convenient to name the parts of the parietal pleura according to the parts of the thoracic wall which they line. Identify therefore, the **costal,** the **diaphragmatic,** the **apical or cervical** and the **mediastinal** pleural surfaces. This last is the medial surface and it faces its fellow of the opposite side but is separated from it by a wide interval, containing the heart and many other important structures, and known as the **mediastinum.**

The lines along which costal pleura becomes diaphragmatic and mediastinal are known as its reflexions. In certain parts of these reflexions the parietal pleura becomes folded back on itself and the two surfaces concerned are not only continuous but in actual contact with one another by their inner or serous surfaces, no lung with its visceral pleura intervening. These are known as **pleural recesses.** The **right** and **left costo-diaphragmatic recesses** are found at the most inferior limits of the parietal pleura. Here the Diaphragm lies so close to the costal wall as to bring costal and diaphragmatic surfaces of the parietal pleura into apposition. The **costo-mediastinal recess** is found only on the left side in the region where the heart lies so close to the anterior thoracic wall as to bring costal and mediastinal surfaces into apposition.

Pass a probe through the lowest part of any of the 7th to 11th intercostal spaces and so satisfy yourself that in these situations Diaphragm and costal wall are in direct contact, not even parietal pleura intervening. If the probe were pushed on through the Diaphragm it would pierce not the pleura, but the peritoneum.

Your dissection has reached the stage where the costal surface of the parietal pleura lies exposed. Get your partner to tilt the lower end of the sternum forwards, then notice

that the pleura sacs of the two sides are in contact with one another along the back of the sternum from the level of the 2nd to the 4th costal cartilage. With the sternum still tilted forwards use the tips of the fingers to free the pleura from the back of the sternum and gradually ease it laterally from its contact with the **pericardium** which is another sac enveloping the heart. Your object is to identify the mediastinal pleura and to peel it off all the structures with which it is in contact in the mediastinal space. You will probably meet with some extra resistance where an important nerve descends from the neck to the Diaphragm. It is the **phrenic nerve.** Observe its position $\frac{1}{2}''$ in front of the root of the lung, and free it from the pleura. It is accompanied by a branch of the internal mammary artery—the **pericardiaco-phrenic artery.**

As the pleura is peeled off the back of the pericardial sac on the right side, and off the lowest part of the sac on the left side, you will be able to observe it passing to the side of the **esophagus.** Behind the esophagus it lies in contact with its fellow of the opposite side and the two layers together form a "**meso-esophagus**" which passes to the descending thoracic aorta where the two layers separate to reach the sides of the vertebral bodies and so each becomes, once more, costal pleura. Demonstrate this fact by opening each pleural sac—if it has not already become torn—and, with a hand in each sac, bring them together behind the lower 2 or 3 inches of the esophagus. Between your hands will be the two layers forming this meso-esophagus. You will finally reach the region where mediastinal parietal pleura becomes visceral pleura at the root of the lung and you will have no difficulty in demonstrating their continuity. Below the root of the lung the line of reflexion from parietal to visceral pleura does not closely encircle the structures in the lung root but reaches

downwards nearly to the Diaphragm. The double layer of pleura thus produced is the so-called **pulmonary ligament.** Identify it.

Next identify and carefully clean the structures at the root of the lung. In order to do this you will, of course, require to remove visceral pleura piecemeal from the lung root. The order of structures in the root of the lung conforms to the relative positions of the structures to which they belong. Thus the **bronchus** is posterior, the **pulmonary artery** above, and one of the **pulmonary veins** below. On the right side, however, a branch of the right bronchus, the so-called **eparterial bronchus** is the highest. In any case no difficulty is experienced in identifying the most posterior structure, the bronchus. It is thick walled, held open by incomplete rings of cartilage and is always empty. The pulmonary artery and the pulmonary veins all contain blood clot. They may best be identified by remembering that in the lung root it is usual to find a vein as the most anterior structure and a vein as the most inferior. On occasion the pulmonary veins are found filled with the injection mass. How does this come about? Next pass the hand round behind the thick posterior border of the lung, free it and ease it forwards. On the left side this border lies tucked behind the descending thoracic aorta. Being careful to avoid injuring lung tissue or phrenic nerve, cut through the structures of the lung root enumerated above and cut also the pulmonary ligament. There may be some pleural adhesions in various places which will need to be broken down or severed. Use the knife sparingly. The lungs, with their covering of visceral pleura, can now be removed for the future study.

Before you proceed any further read your text-book account of the pleura.

THE MEDIASTINA. The midline space between the two pleural sacs has been defined as the mediastinum. It extends from the upper thoracic inlet to the Diaphragm and from the back of the sternum to the bodies of the thoracic vertebrae. Purely for descriptive purposes this extensive space is arbitrarily divided into subsidiary parts. It is essential to know these parts and in describing any structure in the space to assign it to its correct subdivision. A horizontal plane at the level of the sternal angle cuts the disc between the 4th and the 5th thoracic vertebra, and serves to divide the space into **superior** and **inferior mediastina.** This is especially convenient since the plane indicates the level of the upper border of the fibrous pericardium and the level of the bifurcation of the trachea, i.e., the upper border of the root of the lung The inferior mediastinum is subdivided into three portions: (1) the **anterior mediastinum,** the small and unimportant space between the back of the sternum and the front of the pericardial sac; (2) the **middle mediastinum,** containing the pericardium with the enclosed heart and roots of the great vessels; (3) the **posterior mediastinum,** the space behind (and below) the pericardium, and in front of the bodies of the lower 8 thoracic vertebrae. Certain structures traversing the length of the mediastinal space (e.g., the esophagus,) lie, of course, in more than one subdivision.

All students should investigate both sides and become familiar with the structures that are in contact with the right mediastinal pleura, and those that are in contact with the left.

MEDIASTINAL STRUCTURES. Identify the **pericardial sac** and notice that the heart lies more to the left than to the right. Since the right side of the heart is the venous side and the left the arterial, it follows that in the right half of

the mediastinal space veins predominate, and in the left, arteries. Passing over each bronchus is a vascular arch. The smaller venous arch over the right bronchus is the azygos vein, and it arches forwards. The much larger arterial arch over the left bronchus, is the **aortic arch,** and it arches backwards. Possibly due to the great difference in size between these two arches, the (rigid) trachea has been thrust somewhat to the right and as a result is a noticeable feature on the right portion of the superior mediastinum. As a further result the shorter and larger-calibred **right bronchus** is brought more directly in line with the trachea than the longer and smaller-calibred **left bronchus.** It may also be possible that the continuation of the large aortic arch—the **descending thoracic aorta**—is responsible for thrusting the middle section of the **esophagus** in a similar direction, so that it, too, is more apparent in the right half of the posterior mediastinum than it is in the left. With these preliminary observations in mind investigate first the right side of the mediastinum and then the left.

Right side.

The sternum is still in place to serve as a landmark. Notice that the pericardial sac is equal in extent to the body of the sternum and it projects a finger's breadth lateral to the margin of the sternum. Within the pericardial sac on the right side lies the **right atrium** for the reception of blood from the large veins visible on this side. If the veins are full of blood clot this will sufficiently outline them. If not, identify the cut end of the **inferior vena cava** where it pierces the Diaphragm from below, and pass a wicker stick through this vein and upwards through the right atrium and **superior vena cava;** it will emerge through the cut end of the **right innominate vein** which is formed behind the right sterno-

clavicular joint by the confluence of the **right subclavian** and **right internal jugular veins.** Identify all these veins and observe their levels in relation to costal cartilages.

The **azygos vein** arches forwards over the right bronchus to empty into the superior vena cava just before that vessel pierces the pericardium. Observe it and the manner in which it receives the **right superior intercostal vein.** This latter is formed from the **intercostal veins** of the 2nd, 3rd and 4th intercostal spaces. The vena azygos may be full and about as large as your little finger, or it may be much less obvious. In the posterior mediastinum the azygos vein ascends on the vertebral bodies but is somewhat obscured from view by the overlapping esophagus. Identify it here and identify one or two of the other intercostal veins of the right side which it receives. The azygos system of veins will be more fully studied after the heart is removed.

The **right phrenic nerve** courses along the right innominate vein, the superior vena cava, the pericardium covering the right atrium, and inferior vena cava. The nerve passes $\frac{1}{2}''$ in front of the root of the lung and supplies the Diaphragm. Restore it to this position and, if it has been severed in the neck, be sure not to pull it down from the neck but notice that it enters the thorax behind the subclavian vein.

In the superior mediastinum the right side of the **trachea** is readily seen. Identify it and the large flat nerve that runs obliquely infero-posteriorly in contact with it. This is the **vagus nerve.** If it has been severed in the neck tie a piece of string to its cut end and fix it in position. The nerve enters the thorax in front of the subclavian artery and behind the subclavian vein. It next lies briefly postero-lateral to the innominate artery and then on the trachea. It passes medial to the arch of the vena azygos to the back of the root of the lung and it contributes to both **anterior** and **posterior pul-**

monary plexuses. Do not follow it further just now though you may learn that below the level of the root of the lung it, and its fellow, contribute to the formation of the **esophageal plexus** and cling to that structure.

The **esophagus** is visible on the right side throughout almost its entire extent. Above, the trachea partially hides it from view. At the root of the lung, it is hidden by the azygos arch. In its middle section, it is readily seen behind the pericardium overlapping the azygos vein. Below it swings to the left on its way to the stomach. Notice particularly that, as it descends, it intervenes between the pericardium and the descending thoracic aorta.

Now that the lung is removed the positions of the structures as they enter the root should be verified. In addition you may be able to trace some fibres from the vagus nerve contributing to the *anterior pulmonary plexus*. Behind the right bronchus look for an artery (about the size of a posterior intercostal artery) springing from the aorta or from an intercostal artery. It is a **bronchial artery** for the nourishment of the lung tissue.

Since the reflexion from costal to mediastinal pleura passes obliquely down the back of the manubrium from the right sterno-clavicular joint to the middle of the sternal angle it is apparent that certain other of the great vessels above the pericardium are in contact with the right mediastinal pleura. These are the **innominate artery,** the end of the **left innominate vein** and the first part of the **aortic arch.** In addition, the fatty remains of the **thymus gland,** immediately behind the manubrium, must be included.

Left side.

The pericardial sac encroaches much more on the left side than it does on the right. Notice that the apex of the heart

extends out $3\frac{1}{2}''$ from the midline. The next most noticeable feature is the **arch of the aorta.** Identify it and the three main arteries springing from it: (1) the **innominate artery,** springing from the summit of the arch; (2) the **left common carotid artery** with (3) the **left subclavian artery** immediately behind it, both ascending almost vertically in contact with the left mediastinal pleura. The aortic arch, by definition, begins and ends at the same level. This is the sternal angle in front and the disc between vertebral bodies T.4 and T.5 behind; verify this level. Observe that the aorta arches over the left bronchus and then becomes the **descending thoracic aorta** which, lower down, has the **esophagus** interposed between it and the back of the pericardium. Here the esophagus lies somewhat to the right where it and its "**meso-esophagus**" have already been identified. It finally swings to the left and its last inch or more is in contact with the left mediastinal pleura before piercing the Diaphragm. Do not disturb the thoracic aorta or you may tear some of the aortic intercostal arteries seen leaving it for the intercostal spaces. They will be more fully investigated later. All of these features may be made out with little or no dissection.

Since the aortic arch passes from front to back it is of necessity crossed by structures descending vertically. Identify therefore: (1) The **left phrenic nerve.** It descends from the neck and enters the thorax between the subclavian artery behind and subclavian vein in front. Fix its cut end in position in the neck in order not to pull it down into the thorax. Crossing the path of the internal mammary artery, it lies along the side of the left **common carotid artery.** Thereafter, crossing the arch of the aorta, it lies in front of the root of the lung and then on the left side of the pericardial sac. Restore it to this position. (2) **The vagus nerve.** It descends from the neck bound up with the common carotid

artery in the **carotid sheath.** Fix its cut end in position in the neck. It next lies in the angular interval between the common carotid and subclavian arteries but since it is destined to pass behind the root of the lung it crosses the aorta behind the phrenic nerve. A little dissection will enable you to observe that just where the vagus crosses it the aortic arch is connected on its under side to the left pulmonary artery by a stout ligament about the size of a seeker. This is the **ligamentum arteriosum.** The vagus nerve furnishes a recurrent branch—the **left recurrent laryngeal nerve**—which recurs on the lateral or under side of this ligament. Clean the ligament and find the nerve. (3) Between the phrenic and vagus nerves the arch is crossed by two slender *cardiac nerves* which you may have difficulty in finding by now. These come from the sympathetic trunk and from the vagus in the neck and pass to the **superficial cardiac plexus** situated just to the right of the ligamentum arteriosum. Do not delay over them. (4) The vagus and phrenic nerves as they cross the aortic arch are themselves crossed by the **left superior intercostal vein.** Identify it and observe that it conveys blood from intercostal spaces 2, 3 and 4 to the left innominate vein. It clamps the vagus to the arch but it separates the phrenic from the arch.

Above the aortic arch observe the **trachea** and **esophagus** in front of the vertebral column. For reasons already discussed the esophagus projects somewhat to the left of the trachea and so is at once apparent on this side. In the angle between the trachea and the esophagus find once more the recurrent laryngeal nerve. Establish its continuity from the point where it was found before but in doing so be very careful not to injure the **thoracic duct.** This small and thin-walled but important duct ascends through the posterior mediastinum in front of the bodies of the thoracic vertebrae between

the axygos vein and the thoracic aorta. In the region of the aortic arch it crosses to the left (on the body of T.5) behind the esophagus, and is next found on the left side of that structure. Find it there and trace it to the neck where it passes behind the carotid sheath and then curves forwards and laterally in front of the subclavian artery and its branches, to enter the left innominate vein at the site of its formation by the union of the left subclavian and left internal jugular veins.

The chief structures in the root of the left lung enjoy the same relative positions as on the right side, the only difference being that on the left side there is no eparterial bronchus. Proceed therefore as you did on the right side.

Before proceeding further read in your text-book the account of the structures in contact with the right and left mediastinal pleurae.

Although the **sympathetic trunk** does not lie actually in the mediastinum, it is desirable to study it now. Where the mediastinal pleura becomes costal pleura on the sides of the vertebral bodies, is the line of the **vertebral reflexion.** Begin at this reflexion and strip the costal pleura laterally until the sympathetic trunk is uncovered. It lies on the neck of the first rib and then crosses successively the heads of ribs 2–9. Thereafter it lies on the sides of the bodies of the lower thoracic vertebrae and finally, considerably reduced in calibre, passes behind the medial arcuate ligament of the Diaphragm to enter the abdominal cavity. Identify the trunk, note these relations and observe that the trunk is made up of a series of swellings, the **sympathetic ganglia,** connected to one another by nerve fibres. Find the following branches:

1. **Rami communicantes;** (a) **white rami** pass from the spinal nerves (having come from cell stations in the spinal cord), and convey impulses to the ganglia; (b) **gray rami**

pass from cell stations in the ganglia to contribute sympathetic fibres to each spinal nerve. Each thoracic nerve therefore is furnished with both a white and a gray ramus and these, passing laterally, run but short courses ($\frac{1}{2}''$) and are small but stout.

2. Fine branches passing medially from the upper part of the trunk to the **pulmonary** and **cardiac plexuses.**

3. Three **thoracic splanchnic nerves,** the **greater, lesser** and **lowest,** descending medially from the lower part of the trunk and finally piercing the crus of the Diaphragm. The **greater splanchnic nerve**—as large in calibre as the trunk itself—comes from ganglia 6–10. The **lesser,** from ganglia 10 and 11 and the **lowest** from ganglion 12. The splanchnic nerves are but long white rami communicantes.

Read your text-book account of the sympathetic trunk and its ganglia and understand the functional significance of them and of the rami communicantes and the various plexuses.

The Lungs. The lungs may be sponged with water if necessary. Identify the surfaces and borders. The surfaces are **costal, mediastinal,** and **basal** or **diaphragmatic.** Of the borders the **anterior,** is thin and sharp, the **posterior** is full and rounded, the **inferior** is circumferential. The **apex** of the lung rises as high as the neck of the first rib. The right lung is shorter but more voluminous than the left and whereas both lungs are divided into **upper** and **lower lobes** by an **oblique fissure,** the right lung usually has its upper lobe further subdivided by a horizontal or **transverse fissure,** so as to produce in front a small **middle lobe.** Identify these lobes and observe that most of the lower lobe lies at the back of the thoracic cavity and most of the upper lobe at the front. The middle lobe reaches lateralwards only as far as the midlateral line. An effort to make out impressions on the

mediastinal surface is not very satisfying unless the lung has been hardened *in situ* and in any case is but a review of the mediastinal structures already discussed.

Turn to the root of the lung and identify the cut edge of the **pulmonary ligament** and follow the outline of the pleural reflexion completely round the root. It is along this line that **parietal pleura** is continuous with **visceral pleura.** Review the relative positions of the bronchus, pulmonary artery and vein and trace them into the lung substance. In order to do this the blunt end of the closed forceps is all that is needed, for the fat-free lung tissue is readily forced aside. Follow the bronchus until the bronchial tree is made to stand out. Observe that in the lung substance the pulmonary artery quickly takes up a position postero-lateral to the bronchus. Thereafter its branches are always found in this relationship. The pulmonary vein and its branches occupy an anterior position. Read your text-book account of the lungs and their structure.

THE PERICARDIUM: Cut into the **sterno-manubrial joint,** demonstrate that the union is a symphysis, and then separate the manubrium from the body of the sternum. With the handle of the knife, free the manubrium from the loose tissue behind it and tilt it forwards. With the fingers, free the body of the sternum, swing it downwards in order to expose the pericardium, and tie it down with string. From time to time it should be restored to its proper position in order to establish its posterior relations.

The pericardium is a double-walled sac enclosing the heart and the roots of the great vessels. Its outer surface which is now visible is fibrous and appears dull. This **fibrous layer** is gradually lost as it fades away on the surfaces of the great vessels that pierce it. Lining the fibrous layer is the **parietal**

layer of the serous pericardium, which, at the roots of the great vessels, is not carried up on the vessels but is reflected on to the surface of the heart as the **visceral layer of the serous pericardium.** Thus the disposition of the serous pericardium is exactly similar to that of the pleura or peritoneum, and in movements of the heart serous layer glides on serous layer, a minimal amount of serous fluid keeping the two surfaces moist in order to eliminate friction.

Observe the firm adherence of the pericardium to the **central tendon of the Diaphragm.** Thus, as the lungs expand and compress the heart from the sides, the accompanying descent of the Diaphragm allows more room for the heart inferiorly. With fingers and thumb pinch up a fold of parietal pericardium near its upper end, nick it and enter the blunt point of the scissors into the pericardial cavity. Incise the parietal pericardium along the right, lower and left borders. Turn up the U-shaped flap and note the contrast between the inner lining of smooth, glistening serous pericardium and the outer rough and dull fibrous pericardium. Observe also the visceral layer of serous pericardium intimately investing the heart. Run the tip of a finger along the ascending aorta to the summit of the cavity and sweep it round the line along which parietal becomes visceral pericardium. Establish the fact that this line corresponds to the level of the sternal angle.

Insinuate the left forefinger, within the pericardial cavity, between the superior vena cava behind, and the ascending aorta in front, and thence to the left behind the pulmonary artery also. Your finger will emerge on the left between the left auricle and the pulmonary artery and will lie in a serous lined tunnel known as the **transverse pericardial sinus.** The essential relations of this sinus are best understood by observing that all six veins, including the two atria which

receive these veins, lie behind (and below) the sinus; all arteries (aorta and pulmonary) lie in front (and above). When you read an account of the development of the heart and pericardium you will learn why this must be so. Replace the finger by a short wicker stick.

Cut across the inferior vena cava as low as possible within the pericardial sac. Lift up the heart by its apex and, with two fingers, explore the **oblique pericardial sinus** behind the heart. It is a cul-de-sac bound on the sides by the right and left upper and lower pulmonary veins. Observe that above, two layers of serous pericardium separate it from the transverse sinus and that behind only the thickness of the parietal pericardium intervenes between it and the esophagus. Make a longitudinal incision through the posterior parietal pericardium and satisfy yourself that this latter statement is correct. In front of the oblique sinus, when the heart is in position, lies the **left atrium.**

It will greatly aid you in appreciating relations if three other short wicker sticks are passed as follows:

1. Through the right and left pulmonary arteries.
2. Through the right and left upper pulmonary veins.
3. Through the right and left lower pulmonary veins.

Sticks 2 and 3 will of course traverse the left atrium. The stick through the pulmonary arteries lies immediately above and parallel to the upper border of the heart formed by right and left atria.

SURFACE MARKINGS OF THE HEART. Before any further dissection is done investigate the chambers of the heart in relation to its borders and to the chest wall.

Observe that the **upper border** (base) of the heart lies a little obliquely; it is one interspace lower on the right than on the left, and extends from the lower border of the 2nd left

costal cartilage to the upper border of the 3rd right, and in each case reaches a finger's breadth beyond the sternal margin.

The **right border,** consisting entirely of the **right atrium,** extends vertically to the sixth right costal cartilage. It therefore parallels the sternal margin a finger's breadth away.

The **left border** is formed by the **left ventricle** which is responsible for the **apex** of the heart which lies in the 5th left interspace $3\frac{1}{2}''$ from the midline. At its upper limits the **auricle of the left atrium** peeps round from the back.

The **lower border** throughout most of its extent belongs to the **right ventricle.** At the right extremity however accommodation is left for the inferior vena cava to enter the right atrium and the last $\frac{1}{2}$–$\frac{3}{4}''$ of the left extremity belongs to the left ventricle.

Of the chambers, therefore, the right atrium is to the right and in front, the right ventricle is below and in front, the left atrium is entirely behind and the left ventricle is below and to the left and behind. It was the rotation of the heart to the left, occurring at birth, which was responsible for disturbing the original symmetry and carrying the right side forwards and the left side backwards.

Read your text-book account of the surface markings of the heart and of the positions and relations of its borders and surfaces.

When these surface relationships have been verified cut across the stems of the **aorta and pulmonary artery.** The transverse sinus can now be studied more fully. Tear through the serous pericardium between the upper and middle sticks and demonstrate that the right pulmonary artery runs along the upper border of the heart formed by the right and left atria, and that these, with the superior vena cava, form the posterior wall of the sinus. Cut across the **superior**

vena cava about $\frac{1}{2}''$ from its entrance into the right atrium. Lift the heart forwards and upwards by its apex and cut across the four pulmonary veins where they bound the oblique sinus. Do not injure the left atrium. The heart is now held in place merely by those two layers of pericardium, which have already been seen as separating the oblique from the transverse sinus. Incise these two layers and remove the heart.

Identify the obliquely-running groove round the heart which separates atria from ventricles. This **atrio-ventricular groove** is occupied by blood vessels often obscured by fat, but the **coronary sinus,** occupying the groove at the back, is almost always evident for it is often as large as the handle of the seeker, usually filled with blood and itself more than fills the groove. At right angles to the atrio-ventricular groove are the **anterior** and **inferior interventricular grooves** which separate the ventricles from one another and which therefore denote on the surface the situation of the **interventricular septum** in the interior. It is your object now to clean the blood vessels occupying these grooves. Remember that the surface of the heart is still covered with visceral (serous) pericardium which will have to be removed piecemeal as the dissection of the vessels progresses.

Begin with the two **coronary arteries** whose open mouths can be seen by looking into the **ascending aorta.** As each issues from the aorta it is at once obscured by the pulmonary artery whose root is embraced on each side by an auricle. If much semi-fluid fat is present it should be wiped away with cotton wool. Follow the **left coronary artery.** Almost as soon as it leaves the shelter of the left auricle and the pulmonary artery it divides into a larger **anterior interventricular branch,** which follows the anterior interventricular groove as far as the apex, and a much smaller **circumflex branch,** which follow the atrio-ventricular groove to reach the back of the

heart. The size of this latter branch is quite variable. It may quickly diminish in size as it is distributed to the surface of the left ventricle; it may reach the inferior interventricular groove and form a strong anastomosis with the right coronary; or finally, it may actually replace the right coronary in the inferior interventricular groove and so furnish the **inferior interventricular artery.**

Now follow the **right coronary artery.** It follows the atrio-ventricular groove to the right border and then on the inferior (diaphragmatic) surface of the heart, until it reaches the inferior interventricular groove along which it turns, finally to anastomose with the anterior interventricular branch of the left coronary at the apex. The size of any branch continuing in the atrio-ventricular groove towards the left, the so-called **transverse branch,** will, of course, vary with the variability of the left coronary already noted.

It is to be observed that, in effect, there is an arterial ring (crown or corona) in the atrio-ventricular groove; suspended from it is a loop in the interventricular groove. These furnish many branches not only to the surfaces of the heart but also to the muscular walls including the muscular interventricular septum.

The accompanying veins have a somewhat different nomenclature for of necessity they must ultimately reach the right atrium. The **great cardiac vein** begins at the apex, accompanies at first the anterior interventricular branch and then the circumflex branch of the left coronary artery. It thus reaches the back of the heart round the left border where it occupies the atrio-ventricular groove and becomes the **coronary sinus** already identified. The **middle cardiac vein** runs up the inferior interventricular groove to empty into the coronary sinus; the **small cardiac vein** draining the right border of the heart, lies in the atrio-ventricular groove to the right

and reaches the coronary sinus just before that vessel empties into the right atrium. In effect, therefore, the great cardiac vein drains the territory supplied by the left coronary artery, whilst the middle and small cardiac veins drain the territory supplied by the right.

Look for an insignificant vestigial vein descending on the back of the left atrium to empty into the coronary sinus. It is the *oblique vein of the left atrium* and its significance will be understood when the development of the veins is studied.

Read your text-book account of the coronary circulation and of the cardiac veins.

The right atrium.

With the knife make a cut, 1 cm. long, through the tip of the right auricle which is the appendage of the atrium and which partially covers the root of the pulmonary artery. Enter the point of the scissors in the aperture so made, and cut horizontally to the right through the atrial wall, and below the entrance of the superior vena cava round to the posterior aspect of the chamber. From the point just reached, run a vertical cut towards, but falling short of the posterior aspect of the inferior vena cava. Thence carry a cut horizontally forwards across the chamber and to the left, above the inferior vena cava, almost to the atrio-ventricular groove. Turn the flap forwards and to the left and so open the atrium widely. Look at the deep surface of the flap and observe a vertically running ridge, the **crista terminalis,** that you have cut twice. When undisturbed it ran from the right of the superior vena cava to a corresponding position on the inferior vena cava. It is perhaps denoted on the surface of the heart by a groove the **sulcus terminalis.** From the crest parallel ridges, the **pectinate muscles,** pass forwards and to the left. The crest is the anterior limit of a smooth portion

of the chamber between the two caval openings known as the **sinus venarum** (venosus) whose significance you will later appreciate. Running from the lower end of the crest and bounding the opening of the inferior vena cava in front and on its left is a fold, the **valve of the inferior vena cava,** which if followed upwards, outlines a depression on the inter-atrial wall, the **fossa ovalis,** which in turn marks the site of a fetal communication, the **foramen ovale,** for the passage of blood in the fetus from right to left atrium. The foramen commonly is incompletely closed at its upper end. Another small fold, the **valve of the coronary sinus,** partially guards the opening of that sinus, which empties into the atrium between the opening of the inferior vena cava and the large atrio-ventricular (tricuspid) orifice leading to the right ventricle.

The right ventricle.

By inspection pass a blunt instrument down the pulmonary artery between the **cusps** guarding its orifice, well into the ventricle. Make a short transverse cut about an inch long 1 cm. below the determined level of the cusps. Insert a finger through the opening and explore the cavity. Guided by the finger, make a second incision with scissors (blunt point in the ventricle) 1 cm. away from, and parallel to, the atrio-ventricular groove; cautiously extend the incision to the sharp inferior border of the heart. Pull the flap, comprising the greater part of the anterior wall of the ventricle, gently forwards and identify by sight the **anterior papillary muscle** and the **moderator band**; the one arises from the anterior wall and is inserted into adjacent **cusps** of the **tricuspid valve,** the other stretches from the septal wall to the base of the **anterior papillary muscle** Avoiding these structures, make a third incision; this should

start at the left end of the transverse cut and descend to the inferior border 1 cm. away from the interventricular groove. Turn the flap downwards and gently wash out the chamber, taking care not to injure the **chordae tendineae** which are the delicate fibrous cords uniting the apices of the papillary muscles to the cusps of the tricuspid valve. The pulmonary artery may now be trimmed short, so that the three cusps of its tricuspid valve may be better viewed. If the sinuses of the pulmonary valve—the little pockets between the cusps and the vessel wall—are packed with moistened cotton wool and examined from the ventricular aspect, an instructive view is obtained.

Observe the following features:

1. The *cavity* is crescentic in cross-sectional outline since the interventricular septum is convex towards this chamber.
2. The **atrio-ventricular orifice** is to the back and is large enough to admit the tips of 3 fingers.
3. The *orifice* is guarded by three cusps hence the name **tricuspid valve.** These are continuous with one another at their bases but toward the edges are disposed as **anterior, medial or septal,** and **inferior.** Small secondary cusps may be present and obscure the general arrangement.
4. To the surfaces of the cusps not bathed by the entering blood are attached fine cords, the **chordae tendineae,** which gather together like the cords of a parachute and are inserted into the apices of **papillary muscles.**
5. Of the **papillary muscles** the **anterior** is the largest and most prominent. It is attached by its cords to the anterior and inferior cusps. To its base stretches the **moderator band** from the interventricular septum.

The other papillary muscles are much smaller and are irregular in disposition. They are usually designated—though not very profitably—**inferior** and **septal.**

6. The wall of the cavity is roughened by the presence of muscular ridges and bridges. These are known as the **trabeculae carneae.**
7. The **pulmonary orifice** lies above and in front. The cone-shaped portion of the chamber below the opening is the **infundibulum (conus arteriosus).** The blood of necessity takes a U-shaped course to reach the orifice.
8. The **pulmonary valve** consists of three semilunar segments of which two are anterior and one is posterior.

The Left Atrium.

There being little to identify in the left atrium, it is better left unopened for the present.

The Left Ventricle.

Make a cut 1 cm. to the left of, and parallel to, the anterior interventricular groove. The incision is through a wall about $\frac{1}{2}''$ thick. It should extend from the inferior border of the heart to the root of the aorta. As a guide, pass a finger through one of the four pulmonary veins into the left atrium, and onwards through the left atrio-ventricular orifice into the left ventricle.

Trim short the ascending aorta in order to view the three cusps of its valve. Observe the relations of the mouths of the two **coronary arteries** to the **aortic sinuses.** By inspection pass the blunt point of the scissors down the aorta, between a coronary and a non-coronary cusp into the left ventricle, and incise the ascending aorta lengthwise. Let this incision meet the one already made through the ven-

tricular wall. The chamber and the length of the ascending aorta, thus widely opened, are to be studied.

Observe the following features:

1. The *cavity* is cone-shaped in outline and circular in cross section.
2. The *walls* are $\frac{1}{2}''$ thick.
3. The **atrio-ventricular orifice** again is to the back but is smaller than its fellow on the right side of the heart. It will admit the tips of 2 fingers.
4. The orifice is guarded by two **cusps,** hence the name **bicuspid** (mitral) **valve.** The cusps are disposed as **anterior** (**right** or **aortic**) and **posterior** (or **left**). The anterior is the larger and since both its surfaces are bathed with blood during the heart cycle both its surfaces are relatively smooth. Again secondary cusps may be present.
5. **Chordae tendineae** are again present and are attached to two **papillary muscles, superior** and **inferior.** Each papillary muscle is large and is attached by its cords to both cusps.
6. **Trabeculae carneae** are present though somewhat less coarse than those of the right ventricle.
7. The **aortic valve** is composed of three semilunar segments of which one is anterior and two are posterior.

Turn now to the pericardial sac. The **right** and **left pulmonary arteries** are still in place. They should be raised by blunt dissection from the front of the bifurcation of the trachea. A mass of pigmented **lymph glands** surrounds the bifurcation and separates the right pulmonary artery from the esophagus. In removing these glands, the **left recurrent laryngeal nerve** may need to be dissected free. Find the

nerve again and notice twigs from it to the cardiac plexus, esophagus and trachea. Investigate the **cardiac plexus.** It consists of two parts a superficial and a deep. The **superficial cardiac plexus** lies in the concavity of the aortic arch just to the right of the ligamentum arteriosum. The much larger **deep cardiac plexus** lies on each side of the termination of the trachea; it is therefore a paired plexus joined across the trachea by numerous fine fibres. Read an account of the plexus.

Clean the **extra-pulmonary bronchi** and refresh your mind as to the position of the small **azygos arch** and the massive **aortic arch.**

THE SUPERIOR MEDIASTINUM. The superior mediastinum lies behind the manubrium; therefore, tilt the manubrium up and fix it by a string tied to the cervical vertebrae.

Raise the lower part of the **thymus gland.** It is the fatty mass resembling in shape a dog's tongue. It lies immediately behind the manubrium and extends downwards in front of the upper part of the pericardium. Dissect it off the front of the left innominate vein and remove it. The observant dissector will identify two lobes.

Clean the great veins. Halfway down the right margin of the manubrium the two **innominate veins** meet to form the **superior vena cava.** The **azygos arch** enters the superior vena cava extra-pericardially halfway down its length. The veins must be thoroughly cleaned so that they can be freely manipulated.

Clean the sides of the **trachea** and **esophagus** and separate one from the other. Review the positions and relations of the **right vagus** and now, for the first time, observe the fleeting appearance made in the thorax by the **right recurrent laryngeal nerve** where it leaves the vagus and loops subpleu-

rally below the right subclavian artery. On the left, follow the **thoracic duct** downwards, in front of the vertebrae and applied to the esophagus, as far as the junction of the superior and inferior mediastina; then follow it (behind the carotid sheath) upwards to its termination in the left innominate vein or in the angle between the left internal jugular and subclavian veins. In following the duct, the left subclavian artery will need to be eased forwards. Trace the *Longus Cervicis* down from the neck to the limits of its origin from the 2nd thoracic vertebra. Clean the **aortic arch,** after the remains of the pericardium have been removed. Clean its three great branches: **innominate, left common carotid** and **left subclavian.** Review the four nerves and one vein crossing the arch. Pull the left pulmonary artery downwards from the arch and review the **ligamentum arteriosum.** Notice that it runs from the left pulmonary artery to join the arch beyond the origin of the left subclavian artery. The arch is now free; it should be swung to the left, and the superior vena cava should be swung to the right. By this procedure the **trachea** is fully revealed.

Study the superior mediastinum. Read an account of the development of the great arteries. Then dissect the posterior mediastinum.

THE POSTERIOR MEDIASTINUM: The remains of pleura may be removed. The following three structures are to be cleaned and followed together: (1) the **azygos vein** should be followed downwards from its arch. Its tributaries are conspicuous. Observe the cross channels (which are irregular) bringing the blood from the hemiazygos veins; (2) the **thoracic duct** is found between the azygos vein and the descending aorta. Remember it is thin-walled, pale and easily torn. Establish its continuity from the **cisterna chyli** to its termination; (3)

the **descending thoracic aorta.** Clean it and its visceral and parietal branches. Clean the (left) **hemiazygos veins.**

The **esophagus** is now to be cleaned and studied. As this is being done, the right and left vagi will be followed from behind the roots of the lungs, where they were previously seen, to the wall of the esophagus where, with contributions from the sympathetic trunks, they constitute the **esophageal plexus.** This surrounds the esophagus. At the lower end of the plexus find the **anterior** and the **posterior gastric nerve** (one in front of the esophagus, the other behind it) which pass with the esophagus through the Diaphragm.

ARTICULATIONS OF THE COSTAL ARCHES. The **costo-sternal joints** have already been studied, and in one or two spaces certain of the ligaments associated with the costo-vertebral joints have been destroyed. Avoiding these spaces, proceed to study the costo-vertebral articulations. Their similarity to the costo-sternal articulations is to be noted.

Moisten the region to be dissected with two or three drops of water. Manipulate a rib in order to identify the position of its head. With the point of the knife stroke medialwards from the rib head and so clean the **radiate ligament.** Note its attachments. Incise the ligament vertically and open the joint of the head of the rib. Notice it is divided into two synovial cavities by an **intra-articular ligament** which joins the crest of the head of the rib to the intervertebral disc.

The intercostal nerve, with its accompanying vessels, crosses the anterior surface of the **superior costo-transverse ligament.** This strong ligament passes upwards and lateralwards from the neck of the rib to the transverse process above. Sever and turn the intercostal nerve and vessels medialwards and define the ligament. It has a well marked edge between which and the lower margin of the transverse

process the anterior ramus of a thoracic nerve (i.e., intercostal nerve) passes into the thorax and the posterior ramus of an intercostal artery passes out. Define the margin and find the rami. The lateral margin of the ligament is continuous with the posterior intercostal membrane.

Turn the subject over. By manipulating the rib identify the tip of a transverse process and, with the point of the knife, stroke laterally and clean the **ligament of the tubercle** (lateral costo-transverse ligament) which greatly strengthens the articulation of the rib tubercle with the transverse process. Cut the ligament and examine the joint. The posterior aspect of the neck of the rib is now seen to be connected to the front of the corresponding transverse process by the **ligament of the neck** of the rib (inferior costo-transverse ligament).

CHAPTER VI

THE HEAD AND NECK

THE FRONT OF THE SKULL AND THE FACE

The muscles of the face and scalp all belong to the second branchial or gill arch. The upper part of this arch is the styloid process behind which is the stylomastoid foramen from which issues the facial or seventh cranial nerve, the nerve of the arch. It is from the region of the process that the facial muscles have migrated and from the region of the foramen that the branches of the nerve have radiated to accompany and supply them. The muscles include those of the scalp as well as the face and, as the Platysma, extend inferiorly as far as the level of the second rib. Since they are muscles of expression they are subcutaneous and are inserted into the skin where they not only express a variety of emotions but also act as sphincters and dilators for the orifices. Their chief blood supply, the facial (external maxillary) artery, comes from the external carotid artery and, ascending from the neck, enters the face by crossing the lower border of the mandible.

The sensory supply of the face is from the **trigeminal** or fifth cranial nerve and each of the three divisions of this nerve supplies an area. In general these areas may be mapped out by drawing two lines, one from the tip of the nose across the lateral angle of the eye and another from the corner of the mouth to a line about midway between eye and ear. The central V-shaped area is the area of the **ophthalmic division;** the intermediate area that of the **maxillary;** and the 'peripheral' area that of the **mandibular.** In the region in front of

and behind the ear anterior rami of cervicals 2 and 3 reach the face and head whilst the posterior rami of cervicals 2 and 3 look after the back of the head.

Before dissection begins the student should read an account of the NORMA FRONTALIS (front of the skull) with the specimen beside him.

Make the following skin incisions: (1) from vertex to chin in the middle line, encircling the mouth at the red margin of the lips (fig. IX, A to B); (2) from nasion, widely encircling the orbital margin, and back to nasion (fig. IX, C); (3) from the vertex, past the front of the auricle, down to a point a finger's breadth behind the angle of the mandible (fig. X, page 243, A to D).

In removing the flap outlined, begin at the vertex and notice that the skin of the scalp is closely adherent to the thick and tough subcutaneous fascia in which vessels and nerves run; therefore proceed cautiously and leave intact both this tough fascia and the **Frontalis** muscle which lies deep to it. If this flap is raised without difficulty the dissector is probably working too deeply and is in the areolar space deep to the Frontalis and its aponeurosis. The skin of the face is thinner and deep to it there may be a considerable amount of fat; where little or no fat is present the dissector must proceed with especial care for the underlying pale and inconspicuous facial muscles are in immediate danger.

When the flap has been reflected as far as a line half an inch below and parallel to the lower border of the mandible, remove the skin outlined by the orbital encircling incision, observing as you do so how thin and loose is the skin of the lids. Cut the skin free at the lid margins.

The **Platysma** has already been met as a cutaneous muscle of the neck which, crossing the clavicle, reaches as far as the

level of the 2nd rib. Superiorly, its anterior fibres are attached to the mandible just above the lower border and do not invade the face; its posterior fibres cross the lower border of the mandible in front of the angle and run obliquely upwards and medialwards; they are to be dealt with now. If no fat is present, they can at once be seen; otherwise begin by dissecting up the fat along the posterior half of the lower border of the mandible until the pale fibre bundles are uncovered.

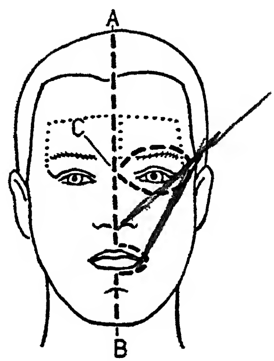

FIG. IX

These fibres, no thicker than a sheet of paper, swing to the angle of the mouth as the Risorius and may be safely cleaned to that level. After the Platysma has been studied, cut the posterior part of the muscle along the lower border of the mandible and reflect it towards the angle of the mouth.

From this point on the dissectors of the LEFT side will pay especial attention to the vessels and nerves, whilst the muscles will be the major concern of the dissectors of the RIGHT side. The needless sacrificing of structures will, of course, be avoided on both sides.

Facial Vessels and Nerve. A finger's breadth below the zygomatic arch the **Masseter,** the rhomboidal muscle that covers the ramus of the mandible, is crossed by the pale **parotid duct,** which lies superficial to the thin layer of deep fascia covering the tendinous portion of the muscle (deep to the fat), and makes a right-angle turn to pierce the **Buccinator,** the muscle occupying the side wall of the mouth. The duct is collapsed, flattened, and may be inconspicuous. It is probably of greater caliber than you expect and looks somewhat like a piece of narrow white tape. Just above the duct runs the **transverse facial artery** and the lower zygomatic branch of the facial nerve. Find and clean the duct and the nerve and also the transverse facial artery if it has been successfully injected.

The **facial nerve** is the motor nerve of the face. Follow the already identified parotid duct backwards across the masseteric fascia to the point where it emerges from the **parotid gland,** which in color and lobulation resembles the pancreas. This point is about $\frac{1}{4}''$ in front of the posterior border of the ramus of the mandible. Raise the anterior border of the gland from the masseteric fascia and find, issuing from the substance of the gland, the flattened branches of the facial nerve. Trace them to the muscles they supply. They run forwards separated from the Masseter only by its fascia. They are, therefore, deeper than you might anticipate. The highest of these radiating branches crosses the zygomatic arch; the lowest, the *cervical branch,* lies close below the angle of the mandible, supplies the Platysma and returns to the face by crossing the border of the bone superficial to the facial artery.

Clean the free, anterior border of the **Masseter** in its whole length, removing the "sucking pad" of fat from the surface of

the Buccinator. The **buccal fat pad** reaches up to the floor of the orbital cavity and so is more extensive than you probably think; do not fear to remove it freely for only by so doing can you satisfactorily expose the **Buccinator** and see piercing it, both the parotid duct and the **buccal branch of the trigeminal nerve** (V^3). This nerve appears from under cover of the upper part of the Masseter. It then runs forwards and downwards to pierce the Buccinator as several twigs. Traced backwards, it is found to pass deep to the ramus of the mandible, commonly through the fibres of the Temporalis. Find and clean it.

Identify on yourself the pulse of the **facial (external maxillary) artery** where that vessel crosses the lower border of the mandible at the anterior border of the Masseter. Its companion vein, the **anterior facial vein,** lies behind it and therefore on the Masseter. Find them on the subject. Trace the artery to the medial angle of the eye. Note the **labial** and **nasal branches,** but do not dissect them out at present. Observe that the artery crosses in turn: the mandible, Buccinator, maxilla and Levator Anguli Oris, and that it ends in the Levator Labii Superioris Alaeque Nasi. These muscles will be dealt with in a moment. Follow the vein to the angle of the eye, taking care of the **deep vein** which brings it into communication with the **pterygoid plexus,** and which is found passing deep to the Masseter at the origin of that muscle from the zygomatic bone.

THE SUPERFICIAL MUSCLES OF THE MOUTH. Define the muscles in this order: (1) **Depressor Anguli Oris,** the triangular muscle running upwards to the corner of the mouth. As its borders are cleaned it should be raised from the underlying quadrangular and more extensive **Depressor Labii Inferioris;** (2) **Zygomaticus Major** (et **Minor**—a mere slip), descending

to the corner of the mouth from the zygomatic bone; (3) **Levator Labii Superioris Alaeque Nasi,** the quadrangular muscles descending to the upper lip and ala of the nose from the inferior orbital margin. The origin of (3) lie under cover of the **Orbicularis Oculi,** the sphincter of the eye, which may be raised to uncover it.

THE DEEP MUSCLES OF THE MOUTH. Cut the Depressor Anguli Oris and reflect it. Define the borders of the **Depressor Labii Inferioris** (particularly the medial border) to where they blend with the **Orbicularis Oris,** the sphincter muscle of the mouth.

To define the *Mentalis* evert the lower lip and incise the mucous membrane horizontally along the line of its reflexion from lip to gums. This line will be above the *incisive fossa* where the somewhat pointed origin of the Mentalis will readily be seen. The muscle is a little pyramid whose base is inserted into the skin of the chin. The fibres seen running almost horizontally lateralwards from beside the origin of the Mentalis constitute the insignificant *inferior incisive bundle* and help to form the deep part of the Orbicularis Oris.

An alternative method for displaying the *Mentalis* is to proceed as follows: Define and free the lateral and medial borders of the Depressor Anguli Oris; pass a probe deep to the muscle and raise it between its origin and insertion. Define the medial and lateral borders of the Depressor Labii Inferioris; the lateral border is partly under shelter of the Depressor Anguli Oris. Raise the muscle in similar fashion. Between the medial border of the Depressor Labii Inferioris and the midline is the cylindrical (pyramidal) little muscle, the Mentalis, whose deeply placed origin from the incisive fossa is under shelter of the Depressor Labii Inferioris and whose insertion is into the skin of the chin.

Clean the surface of the **Buccinator** whose situation has already been noted; define its upper and lower attachments to the outer surfaces of the alveolar processes of the maxilla and mandible respectively. The muscle is continuous pos-

teriorly with the **Superior Constrictor** of the pharynx, a delicate, inconspicuous, fibrous raphe, the **pterygo-mandibular ligament,** marking the line of junction. Thus the side wall of the mouth becomes the side wall of the pharynx. You may not be able to see the raphe at present and in any case do not try to investigate it further, but endeavour to make out the manner in which the fibres of the Buccinator contribute to the Orbicularis Oris.

With a probe loosen the tissues deep to the Levator Labii Superioris; this is the space into which the **infra-orbital nerve** issues from its foramen. By carefully cutting through the Levator, expose this nerve (and its companion vessels). It at once breaks up into a leash of branches; look carefully for the delicate branch that turns upwards into the lower eyelid; heavier branches to the side of the nose and to the upper lip are easily found. Pass a seeker upwards and lateralwards into the **infra-orbital foramen** in order to demonstrate its direction. The nerve appears on the face deep to the Levator Labii Superioris and superficial to the Levator Anguli Oris.

Clean the **Levator Anguli Oris,** the thin and delicate muscle which arises from the maxilla well below the infra-orbital foramen and remains applied to the maxilla.

THE LOWER LIP. Make a midline incision through the entire thickness of the lower lip and parallel to this make a second vertical incision downwards from the angle of the mouth. Turn down the quadrangular piece of lip. Cut through the mucous membrane along the line of its reflexion from lip to gums, and dissect it from the underlying muscle fibers up to the red line of the lip. Observe the carpet of **labial glands** immediately deep to the mucous membrane, and, at the red line, see the **inferior labial artery** (the cut end of the artery may, of course, be seen in the cut edge of

the flap). The nerve fibers seen ascending on the flap are branches of the **mental nerve.** Now strip the flap from the bone until the mental nerve is seen issuing from the **mental foramen** $1\frac{1}{4}''$ from the median plane. Run the seeker downwards and medialwards into the foramen to demonstrate its direction.

The External Nose.

The muscles present little difficulty but they are thin, small and unimportant. The *Compressor Naris* lies over the upper cartilage and is continuous above with the *Procerus*—an extension of the Frontalis on to the root of the nose. The **Frontalis** is the broad muscle occupying the front portion of the scalp. Lateral to the Compressor, and sending a slip to the lower nasal cartilage, is the Levator Labii Superioris Alaequae Nasi already dissected. Lying on the maxilla medial to, and on the same plane as, the Levator Anguli Oris there is a muscular sheet whose fibers fan to the septum and lower and lateral parts of the nasal orifice. The parts of the sheet are known as the *Dilator Naris* and the *Depressor Alae Nasi*. Do not waste time on them.

Trace twigs of the infra-orbital nerve on to the dorsum of the nose and below the ala into the vestibule. Find, making its exit between the nasal bone and the upper nasal cartilages, the **external nasal nerve**; it may be traced to the point of the nose.

Dissection of the nasal cartilages. Read an account of them first. Keep the blade of the knife applied flat to the nasal bone and clean downwards the nasal bone. When the lower edge of the nasal bone and the anterior edge of the maxilla are reached you will meet fibrous tissue which almost imperceptibly becomes the thin posterior edge of the **upper nasal cartilage.** As you clean downwards the surface of this cartilage you will find it becoming progressively thicker, particularly in the median plane where the paired cartilages meet.

You should, however, be able to demonstrate that the cartilages are in reality, not independent structures, but merely triangular expansions of the **septal cartilage.** The septal cartilage can be seen extending downwards in the midline beyond the upper cartilages and between the paired lower cartilages.

The **lower nasal cartilages** are U-shaped and independent; each consists of a **medial** and a **lateral crus.** If you palpate the tip of your own nose you can feel the cleft between the medial crura of the two sides. By a small midline incision at the tip of the nose, separate these two crura and see the lower edge of the septal cartilage between them. Trace it to the anterior nasal spine. Then clean the surface of the lateral crus to its attachments to the maxilla and, in that vicinity, look for small *accessory cartilages.*

THE EAR. First read an account of the **cartilage of the auricle.** To display it start in front of the **helix** and keep the surface of the blade of the knife at all times applied to the cartilage. Free the skin all the way round the helix till the **cauda** is reached. Define the **spine** at one end of the helix and the cauda at the other. Branches of the **posterior auricular artery** will be seen turning round the helix on to the lateral surface of the auricle. Repeat the procedure, working now from the **tragus** towards the cauda of the helix, separating the fatty lobule from the tragus and cauda. With the assistance of your partner, who should pull the auricle forwards, dissect the cartilage from the soft tissues behind it. When this rather tedious dissection is satisfactorily completed, a single piece of cartilage will be free from all attachment, except where the cartilage of the tragus is seen to be continuous with the **cartilage of the meatus** which in turn is attached to the **bony meatus.** It is your objective

to demonstrate this continuity. Thus, if, after dividing the tissue binding the spine to the tragus, you take hold of the cartilage of the tragus and swing it circularly backwards and downwards, you will readily demonstrate that it forms the front, upper and lower walls of the cartilaginous meatus, and that it is deficient behind. The hair-bearing piece of skin, limited to the outer part of the meatus, may be observed and removed. Remove the skin from the lateral surface of the auricle, and see a large branch of the posterior auricular artery piercing the cartilage and perichondrium above the crus of the helix. The muscles, vessels and nerves of the auricle will be dissected later.

THE EYE. Read an account of the following structures and since all of them can be made out by inspection or palpation on the living eye, use a mirror or seek the co-operation of your partner:

1. **Palpebral commissures,** uniting the eyelids medially and laterally.
2. **Palpebral fissure,** the opening between the lids.
3. **Medial** and **lateral canthi,** the angles of the fissure.
4. **Cornea,** the anterior transparent $\frac{1}{6}$ of the outer coat of the eyeball.
5. **Sclerotic coat,** the yellowish, opaque, posterior $\frac{5}{6}$ of the outer coat of the eyeball.
6. **Iris,** the varied-coloured diaphragm seen through the cornea.
7. **Pupil,** the aperture of the iris.
8. **Conjunctival sac,** the space between eyeball and eyelids.
9. **Conjunctiva,** the membrane lining the sac.
10. **Fornices,** the regions of conjunctival reflexion from eyelid to eyeball.

11. **Medial palpebral ligament,** felt as a rounded cord deep to the medial commissure when the lateral commissure is pulled laterally.

Inspect the lid margins. The lateral $\frac{5}{6}$ of each is flat and thick and carries lashes or **cilia.** Behind the cilia may be seen the pin-point orifices of the **tarsal glands** (of Meibom). The glands, situated within the **tarsi** or **tarsal plates,** may be seen as yellowish streaks shining through the conjunctiva lining the backs of the lids. The medial $\frac{1}{6}$ of each lid margin bounds a triangular area—the **lacus lacrimalis**—and is rounded and contains a **canaliculus** which conducts the tears to the **lacrimal sac.** A minute aperture, the **punctum lacrimale,** situated on a little eminence, the **papilla,** may be seen at the junction of the ciliary and lacrimal parts of the lid margin.

Proceed to dissect the **Orbicularis Oculi.** Since its origin is from the medial part of the bony orbital margin and from the medial palpebral ligament, the **orbital** (peripheral) **part** of the muscle should first be raised at its lateral part and reflected medially from the frontal bone and temporal fascia. In so doing its nerves will be severed. Next the **palpebral part** should, in each lid, be raised off the underlying **palpebral fascia** as far as the lid margins and also turned medially. When this is done the attachment of the **medial palpebral ligament** to the frontal process of the maxilla can be defined.

Make a vertical midline incision through all layers of the scalp to the bone, running upwards from the nasion, the depression at the root of the nose, to a point $1\frac{1}{2}''$ above the glabella, the smooth eminence above the nasion. Parallel to this make a second incision, upwards from the zygomatic process of the frontal bone (lateral angular process). Join the upper ends of the two incisions (fig. IX, dotted lines). Separate from the frontal bone the quadrangular flap thus outlined and turn it down. Its attached base is just above

the orbital margin. (If periosteum has accidentally been raised with the flap, remove it.) In the flap, define and clean the following structures: Corrugator Supercilii, Frontalis, supra-orbital nerve and vessels and supratrochlear nerve and vessels. The **Corrugator** fans laterally and somewhat upwards from the glabella and pierces the Frontalis. Define the **Frontalis** and appreciate that anteriorly it interlaces with the Orbicularis Oculi to reach the skin. The posterior layer of its delicate areolar sheath is attached to the orbital margin and must be severed; the muscle itself has no bony attachment. Find the **supra-orbital nerve** and **vessels** emerging from the notch of the same name, a full inch from the median plane. Trace their medial and lateral branches in the flap. A short distance medial to these nerves and vessels find the *supratrochlear nerve* ascending between the fibers of the Corrugator. [The minute *diploic vein* that emerges from the pin-point orifice in the supra-orbital notch may perhaps be seen.] Cut the Corrugator long, and continue the reflexion of the flap downwards as far as the superior margin of the orbit and the medial palpebral ligament, then remove the flap entirely. This is a suitable time to follow the **anterior facial vein** to its origin in the supra-orbital and supratrochlear veins.

The **palpebral fascia** lies exposed. Read an account of it and examine its attachments. Examine the **tarsus** (tarsal plate) and note its continuity with the palpebral fascia. Each tarsus is a condensed fibrous thickening of the palpebral fascia which stiffens the eyelid. The upper is D-shaped; the lower is band-like. Evert the upper lid and examine its free margin. Observe the several rows of **cilia** occupying the anterior portion of the margin. If, with the handle of the scalpel, the deep surface of the lid be firmly stroked towards its margin, secretion will be expressed from the **tarsal glands** that lie

within the plate, and thus the mouths of the glands, behind the cilia, will be rendered conspicuous. Cut through the palpebral fascia in its upper lateral quadrant close to the orbital margin. Pass the seeker through the cut and, keeping the point close to the bony orbital roof, free the **lacrimal gland** from its bony bed, observing there also a lobule of orbital fat. The gland is wrapped round the curved lateral margin of the **aponeurosis of the Levator Palpebrae Superioris,** and extends downwards as far as the **lateral palpebral raphe.** Pass the seeker behind this margin, define it to its attachment and appreciate that it acts as a **lateral check ligament** for the muscle. The less well-developed medial margin (a medial check ligament) is not so easily defined. Behind the medial part of the orbital margin a sheet of fascia stretches from the **anterior** to the **posterior lacrimal crest.** It closely covers the **lacrimal sac.** The medial part of the palpebral fascia also is attached to the posterior lacrimal crest. To find this attachment, cut carefully along the anterior crest and reflect the sheet of fascia covering the sac. Puncture the sac below the medial palpebral ligament and with the point of the probe explore its extent: it reaches above the ligament. If a suitable probe be passed downwards and lateralwards within the sac, it will traverse the **naso-lacrimal duct** and enter the inferior meatus of the nose.

If you have time it will repay you to carry out the following procedure to display the **pars lacrimalis** of the **Orbicularis Oculi** (Horner's muscle): With a pair of scissors cut vertically through both lids dividing them into medial and lateral halves. Turn the medial halves over as flaps towards the nose. Dissect their deep surfaces towards the lacrimal bone and you will readily expose the pars lacrimalis of the Orbicularis Oculi and demonstrate that it reaches from the posterior lacrimal crest to the tarsal plates at their medial ends. Its function is to pull the lids medially and so bring the puncta into the **lacus lacrimalis** and permit the tears to enter the canaliculi.

THE SENSORY NERVES OF THE FACE. The larger and more important sensory nerves have been found. They are branches of the ophthalmic (V^1), maxillary (V^2) and mandibular (V^3)—the three divisions of the trigeminal nerve. The remainder now to be dissected are: the *lacrimal* and *infratrochlear* branches of V^1, the *zygomatico-facial* and *zygomatico-temporal* of V^2 and the **auriculo-temporal** of V^3. Do not delay long over the first four, since you may not be successful in finding them.

The *lacrimal nerve* twigs are to be sought coming through the gland. The *infratrochlear* appears above the medial palpebral ligament in company with the *dorsal nasal branch* of the ophthalmic artery and a connecting vein between facial and ophthalmic veins. The *zygomatico-facial* emerges through a foramen situated at the point of intersection of the projected inferior and lateral margins of the orbit. Cut down, therefore, to bone above that level and work downwards. The *zygomatico-temporal* pierces the temporal fascia behind the zygomatic tubercle; it runs upwards.

The **auriculo-temporal nerve** issues from the depths at the level of the lower border of the tragus and turns upwards in the superficial fascia. It ascends immediately behind the **superficial temporal artery,** but separated from it by a thin fascial sheet. Make a vertical cut immediately in front of the tragus into the superficial fascia, which is here fibrous. Clean the nerve and its companion superficial temporal vessels. Besides giving off the **transverse facial artery** already dissected, the **superficial temporal artery,** as it crosses the posterior root of the zygoma, gives off the **middle temporal artery** which immediately pierces the temporal fascia to pass behind or through the posterior fibres of the temporal muscle. Identify it, then trace the superficial temporal artery to its division into **anterior** and **posterior terminal branches,** which ramify in the scalp over the frontal and parietal regions respectively; the anterior branch is often highly tortuous.

THE SCALP

The hairy covering of the cranial vault, known as the **scalp,** consists of four layers which from without inwards are:

1. **Skin**—generously equipped with sensitive tactile organs, the hair of the head.
2. **Superficial fascia**—exceedingly tough, thick, dense and adherent to the skin. In it vessels and nerves run and ramify.
3. **Muscular layer**—consisting of **Frontalis** in front and **Occipitalis** behind, the two united by a broad tough fibrous sheet, the **epicranial aponeurosis** or **galea aponeurotica** (galea = a helmet).
4. **A very loose areolar layer**—sometimes called the "dangerous layer" owing to the ease with which infection can spread in it—separating the first three layers from the **pericranium** or periosteum of the cranial vault, and permitting the Occipito-frontalis to produce a limited amount of movement.

The vessels reach the scalp from all around its periphery. Bleeding, which may be excessive, can be controlled therefore by a tight bandage round the circumference of the head.

The sensory nerves also reach the scalp from around its periphery and come from the fifth cranial nerve and both anterior and posterior rami of cervical nerves 2 and 3.

The scalp has already largely been removed from the anterior portion of the cranial vault. Therefore, make a midline incision through the skin from vertex to inion (fig. X, A to F), and a horizontal incision from inion to the base of the mastoid process (fig. X, F to G). Reflect the skin from the closely adherent subcutaneous layer and remove it. In so doing, you will demonstrate that the subcutaneous

layer is thick and tough and that the vessels and nerves run in it. Then incise the remaining layers of the scalp from vertex to inion and from vertex to just above the ear. These incisions go down to bone. Reflect downwards the flaps with the contained vessels and nerves, both from the vault and from the **temporal fascia** on the side of the skull. If this is done with the fingers rather than with the blade of the knife,

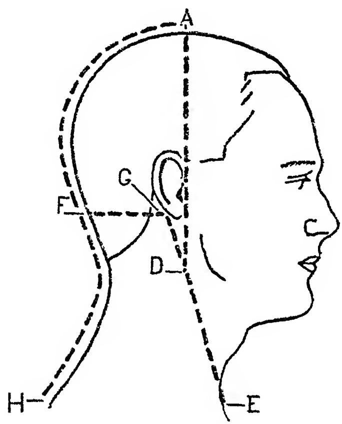

FIG. X

the loose areolar space beneath the flap will be found to be irregularly loculated. At the level of the zygomatic arch and at the superior nuchal line the loose areolar layer is closely adherent to bone.

An endeavor should be made to display the *anterior*, *superior* and *posterior muscles* of the ear. The anterior and superior each form a thin, triangular, Platysma-like sheet and each arises from a downward extension of the epicranial aponeurosis. The posterior is a broad band arising from mastoid bone. They are most readily found where they spread from the ear.

The **Occipitalis**, comparable in size to the Frontalis, ascends from the superior nuchal line and is contained in the posterior flap. The sheet of **epicranial aponeurosis** which connects it to the Frontalis must be examined. The cutaneous vessels and nerves at the front of the ear must be followed from the point where they are already displayed. Those behind the ear are to be left till the posterior triangle of the neck is dissected.

THE POSTERIOR TRIANGLE OF THE NECK

This region is largely concerned with important structures making their way to the upper limb; it belongs in effect to the 'root' of the limb. The triangle is bounded by the posterior border of the **Sternomastoid** in front, the anterior border of the **Trapezius** behind, and the upper border of the clavicle below. Once the subclavian vessels have gained the posterior triangle by ascending from the thorax and crossing the upper surface of the first rib, three regions concerned with the root of the limb are accessible to them and to the branches of the brachial plexus: (1) the **axilla,** via the "cervico-axillary canal" behind the clavicle; (2) the **supraspinous fossa** (and shoulder joint), and the **infraspinous fossa** via the spinoglenoid (scapular) notch; (3) the **vertebral border of the scapula** and the muscles attached to it. All of these regions were examined by the dissectors of the upper limb, but it is useful to recall them now and to link up the vessels and nerves as they are now met with their continuations with which the dissector is familiar.

The posterior triangle possesses: (1) a **fascial roof** which stretches between the two muscles forming its boundaries and splits to embrace them; (2) a series of muscles covered with fascia and forming a **floor;** (3) **cutaneous veins** lying superficial to the roof and **cutaneous nerves** piercing the roof;

(4) **contents,** consisting largely of vessels and nerves which, as already noted, belong in the main to the upper limb.

If not already done, make an incision along the clavicle from its medial end to a point 1″ beyond the tip of the acromion (fig. II, A to B). Make a second incision from the medial end of the clavicle to the base of the mastoid process (fig. X, E to G). Reflect the skin to a point, at its upper end, midway between the mastoid and the inion; and at its lower end, to the acromion. The anterior border of the Trapezius is to be well exposed but the anterior triangle, which lies medial to the Sternomastoid, must not be uncovered.

The postero-inferior portion of the **Platysma** is laid bare. It crosses the whole length of the clavicle, and underlying it a series of cutaneous nerves also crosses the clavicle. If not previously done, cut the Platysma along the clavicle, being careful not to injure the nerves; then reflect it upwards and forwards within the limits of the skin incision. The fascial roof of the posterior triangle, i.e., the investing layer of deep fascia, is now exposed. It splits in front to embrace the Sternomastoid, spans the triangle, and splits behind to embrace the Trapezius. Read an account of it.

The first structure to be sought is the **accessory nerve.** Its course is marked out by a line extending from a point somewhat above the middle of the posterior border of the Sternomastoid to a point more than two fingers' breadth above the clavicle, at the anterior border of the Trapezius. Prolonged upwards this line would reach the tip of the transverse process of the atlas, which is placed postero-superior to the angle of the jaw deep to the mastoid process. Make a superficial cut through the fascial roof along this line; find and dissect free the accessory nerve. It comes into the posterior triangle through the fibers of the Sternomastoid and

there you will find **lymph glands** clustered around it. Hooking round the lower border of the nerve where it emerges from the muscle, find the **lesser occipital nerve** and trace it along, or near, the posterior border of the Sternomastoid to the scalp. Some of its twigs ascend on the surface of that muscle. As the lesser occipital nerve is being followed, clean the posterior border of the **Sternomastoid** right up to the apex of the posterior triangle where, below the superior nuchal line, the Sternomastoid meets the Trapezius in an aponeurotic junction. Just below this junction the **occipital artery** flits across the apex of the triangle; it must be preserved. There is no other structure in the posterior triangle above the accessory nerve, so here you may safely clean also the muscles that form the floor. If the boundaries and floor of the upper portion of the triangle are left clean and well defined now, you will be saved considerable trouble later on.

Also radiating from near the midpoint of the posterior border of the Sternomastoid are: (1) the **lesser occipital nerve** already found; (2) the **great auricular nerve;** (3) the **anterior cutaneous nerve of the neck;** and (4) the **supraclavicular nerves.** The **great auricular nerve** ascends vertically on the surface of the Sternomastoid; the vein lying either immediately, or a short distance in front of it, is the **external jugular vein.** The nerve supplies a cutaneous area whose centre is near the angle of the jaw and which reaches from near the angle of the mouth to the mastoid process. It has therefore *facial*, *auricular* and *mastoid* branches. Trace these branches. The **anterior cutaneous nerve of the neck** runs transversely across the middle of the Sternomastoid and crosses either superficial or deep to the external jugular vein. It is the sole cutaneous supply to the anterior triangle; identify it now, preparatory to following it later. Trace the **supraclavicular nerves** spreading downwards and

laterally to cross the clavicle and acromion from end to end: some branches pass deep to the Trapezius and help to supply it with sensory fibers.

The **external jugular vein** runs superficially from a point just behind the angle of the jaw to a point one inch above the clavicle at the posterior border of the Sternomastoid where it pierces the deep fascia. (If the dissector places the arm across the chest, the clavicle will be protracted and more room afforded.) Remove the remains of the fascial roof of the triangle. In the lower part of the triangle observe the **inferior belly of the Omohyoid,** a ribbon-like muscle as wide as your forceps, lying within an areolar sheet which acts as an inverted sling and fades away above in the fascial "carpet".

Identify three variable veins joining the external jugular vein at the root of the neck: (1) the **transverse cervical vein** and (2) the **suprascapular vein** run medially to enter the external jugular vein before the latter goes deep by piercing the fascial sling of the Omohyoid. Each is accompanied by an artery of the same name whose course in the posterior triangle will be noted in a moment; (3) the **anterior jugular vein,** coming from the anterior triangle of the neck, runs laterally along the upper border of the medial end of the clavicle and behind the Sternomastoid, to enter the external jugular vein at the posterior border of that muscle.

Trace the posterior belly of the Omohyoid, as far as you are able, towards its attachment to the scapula. Remove the "omohyoid fascia," noting that the external jugular vein pierces it to enter the **subclavian vein,** which, crossing in front of the Scalenus Anterior, rises no higher than the clavicle.

The **subclavian artery** rises to a somewhat higher level than the corresponding vein for it passes behind the Scalenus

Anterior and is therefore higher up on the upper surface of the sloping first rib. The artery can be seen now emerging at the lateral border of the Scalenus Anterior and immediately above it is the **brachial plexus** to be dealt with in a moment. Springing from the first part of the subclavian artery, i.e., that part which is medial to the Scalenus Anterior and therefore inaccessible just now, is a short trunk, the **thyro-cervical trunk,** two of whose branches run, like the subclavian vein, across the anterior surface of the Scalenus Anterior and can be investigated now. They are: (1) the **transverse cervical artery,** lying about a finger's breadth above the clavicle, and running deep to the Omohyoid to gain the anterior border of the Levator Scapulae, where it splits into a superficial and a deep branch one on each side of the muscle; (It may either meander through the brachial plexus or cross it superficially.) (2) the **suprascapular artery,** running close behind the clavicle parallel to, but at lower level than, the transverse cervical artery and making for the suprascapular notch. Clean both vessels within the limits of the region. Either vessel may arise from the third part of the subclavian artery and in that case will not cross the Scalenus Anterior. Their further courses were investigated when the scapular region was dissected. Review them throughout.

Clean, without injuring, the transparent fascial "carpet" that covers the muscles of the floor of the triangle. Observe for your guidance: first, that the posterior border of the **Scalenus Anterior** is parallel to and just behind the posterior border of the Sternomastoid, and that the muscle is crossed anteriorly by the subclavian vein; secondly, that the **brachial plexus** and **subclavian artery** emerge between the Scalenus Anterior and the **Scalenus Medius;** thirdly, that the accessory nerve lies superficial to the **Levator Scapulae** and is the

guide to it; lastly, that the **Splenius** is the muscle above the Levator Scapulae.

The exposure of the motor nerves deep to the fascial carpet. These, with the exception of the phrenic nerve and the nerve to the Subclavius, take parallel courses between the accessory nerve above and the brachial plexus below. They are to be exposed and cleaned in the following sequence. Pull forwards the roots of the supraclavicular nerves (C.3 and 4) and find two or three small **nerves to the Levator Scapulae** arising in conjunction with them. Working in the interval between the anterior border of the Scalenus Medius and the roots of the brachial plexus, while the handle of the forceps forcibly holds the plexus forwards, pick up the **nerve to the Rhomboids** (C.5) and the **nerve to the Serratus Anterior** (C.5 and 6). These pierce the anterior fibres of the Scalenus Medius, so pick them up again where they emerge from that muscle ½″ lower down. Follow the nerve to the Rhomboids to where it passes deep to the Levator Scapulae, and follow the branch to the Serratus Anterior into the upper digitation of that muscle. This digitation is the upper portion of a horizontal sheet of muscle fibres, and it runs from the first rib, near the insertion of the Scalenus Medius, to the superior angle of the scapula. Still holding the plexus forwards, observe leaving its posterior aspect, a loose branch (C.7) which descends between the back of the plexus and the Scalenus Medius into the axilla. (Like the branches of C.5 and C.6 it may pierce the Scalenus Medius.) It supplies the lower part of the Serratus Anterior. Remember that all these nerves run parallel courses. The *nerve to the Subclavius* (C.5 and 6) comes off the front of the upper trunk of the plexus, passes downwards anterior to the plexus, and enters its muscle at about the middle of the clavicle. This nerve though small is im-

portant for it often carries the fibres of C.5 destined to join the phrenic nerve later on. The **phrenic nerve,** a branch of the cervical plexus (C.3 and 4) with a twig from the brachial plexus (C.5), descends vertically across the surface of the Scalenus Anterior deep to the internal jugular vein, and transverse cervical and suprascapular arteries. Remember again that all these nerves are deep to the fascial floor carpeting the muscles.

Like the Omohyoid fascia, the **axillary sheath** (i.e., the tubular sheath of fascia that encloses the plexus and axillary vessels) adheres to the back of the Subclavius fascia. Place the handle of the seeker between the subclavian artery and the plexus (and therefore within the sheath) and gently persuade it to pass into the axilla. Now trace the **subclavian vein** to its junction with the **internal jugular vein.** Clean the **brachial plexus** within the limits of the posterior triangle and clean the muscles of the floor. If you separate the plexus from the subclavian artery, you will see the **dome of the pleura** rising between the Scalenus Anterior and the medial border of the first rib.

THE BACK

Examine the attachment of the **Occipitalis** to the superior nuchal line. Its continuity with the epicranial aponeurosis has already been observed. Make a midline incision from the inion down the cervical vertebral spines (fig. X, F to H) and remove the skin from the back of the neck, if not already done. Read an account of the posterior rami of the spinal nerves. They have been dissected in the thoracic and upper lumbar regions. Look first for the **greater occipital nerve.** It pierces the Trapezius $1\frac{1}{4}''$ infero-lateral to the inion and ascends to beyond the lambda, accompanied by the occipital artery on its lateral side. Owing to the density of the deep

fascia, this nerve may be hard to find, although it is quite large. An alternative and simpler method is to raise the anterior border of the Trapezius (already defined) about $1\frac{1}{4}''$ below the apex of the posterior triangle and seek the nerve coming from the depths through the Semispinalis Capitis, before it pierces the Trapezius. Find cervical nerves 3, 4 and 5 which are lower down and equally spaced.

If not already done, cut the skin along the midline of the sacrum to the tip of the coccyx. Reflect it laterally and perchance find the *cutaneous filaments of sacral nerves* 1, 2 *and* 3. Identify the *cornua of the sacrum and coccyx* and the *sacral hiatus*. Cut away the very dense aponeurosis closing the sacral canal below the hiatus (denser than fascia lata) and, with the seeker and by wiping, expose the *filum terminale, sacral nerve 5* and *coccygeal 1*. If you are interested, trace them with the aid of a lens to their terminations. They are very small and relatively unimportant, so do not delay over them.

Reflect and remove the upper half of the Trapezius; the lower half has been reflected already. Two muscles are uncovered: (1) the broad muscle whose fibres run obliquely upwards and lateralwards is the **Splenius**; (2) the muscle whose vertically running fibres are seen between the diverging upper oblique borders of the two Splenii is the **Semispinalis Capitis.** If the greater occipital nerve was not previously found, it will easily be picked up where it pierces the Semispinalis Capitis about $1\frac{1}{4}''$ below the inion, because the fascia here is sparse; the **occipital artery** will be found coming from under cover of the upper limits of the Splenius and approaching the nerve from the lateral side.

Detach the Latissimus Dorsi from the lumbar fascia. Remove the Rhomboids, and deep to them see and clean a muscle with similar origin, structure and direction, but smaller, thinner, and with different insertion, for its fleshy fibres extend to the upper ribs lateral to their angles. This

is the **Serratus Posterior Superior.** Remove the loose areolar tissue on which the Latissimus plays. The **Serratus Posterior Inferior,** which is twice as wide and twice as thick as the Superior, lies over the lower part of the thorax covered only by the Latissimus Dorsi. Like the Latissimus, it takes origin from the vertebral spines via the lumbar fascia; its broad fleshy bands are inserted into the lower borders of the lowest four ribs lateral to their angles. Continuous with its upper border is a thin fascial sheet, the **vertebral aponeurosis.** Divide and reflect the Serratus Posterior Superior.

To display the **Splenius,** detach the Sternomastoid from the superior nuchal line to within an inch of the tip of the mastoid process, and turn it laterally. Clean both surfaces of the **Levator Scapulae** and define its four slips of origin. This is speedily accomplished by touches of the knife, if the muscle is kept taut by an assistant. Display the oblique upper and lower borders of the Splenius. Divide and reflect it. Observe the **Splenius Cervicis** has the same upper attachments as the Levator Scapulae, and the **Splenius Capitis** as the Sternomastoid.

In the lumbar region pinch the vertebral aponeurosis free from the underlying **Sacrospinalis** for which it helps to form a sheath; snip it, and, by inserting the closed forceps and running their limbs downwards, with the point of the knife between them, slit it. Continue the vertical cut downwards through the **posterior lamella of the lumbar fascia,** which is here very dense, right to the coccyx. Reflect the flaps medially and laterally. It may be necessary to dissect them off the Sacrospinalis. Leave the middle and anterior lamellae of this lumbar fascia for the dissectors of the abdomen, because the practical interest of these two layers

lies in the fact that they are encountered in the surgical approach to the kidney.

THE DEEP MUSCLES OF THE BACK. *The longitudinal group.* The **Sacrospinalis** lies exposed. Its three columns—lateral, intermediate, and medial—are most easily separated from one another by starting in the middle or the upper thoracic region. The issuing nerves form a rough guide to the interval between the intermediate and lateral columns. The lateral column is the **Ilio-costo-cervicalis.** Clean the tendinous slips it gives to the angles of the ribs—they are quite obvious. Separate it from the intermediate column, the Longissimus, and turn it over laterally, like the page of a book. Clean the slips the Ilio-costo-cervicalis picks up from the angles of the ribs. Separate the part which is inserted from the part which is just arising. When the final insertion of the lowest bundle is reached, it will be seen that new origins have accumulated into a second bundle which continues the column higher. It, in turn, now is inserted on the upper six ribs, while under cover of it a third bundle arises which proceeds into the neck. Trace it throughout; it does not reach the head. Clean the slips the **Longissimus** gives to the ribs midway between the angles and the tubercles, and deal with the muscle similarly. Clean the slips it gives to, and picks up from, the transverse processes. Trace its cranial extension, the **Longissimus Capitis,** to the mastoid process, where it lies under cover of the Splenius Capitis. The **Spinalis** is the medial fibrous and stringy remnant clinging to the spines. It is thin and $\frac{3}{4}''$ wide. Find its free lateral edge, raise it from the underlying **Semispinalis Thoracis,** turn it medially and remove it entirely.

The oblique group. Trace the greater occipital nerve

through the vertically running fibers of the **Semispinalis Capitis** and preserve it. The medial border of the muscle is free and rounded and is separated from its fellow by a median sheet of fascia, the **ligamentum nuchae** which should be studied. Do not remove the ligamentum nuchae but separate the muscles from it on both sides thus retaining the ligament as a midline partition. Identify the lateral free border of the Semispinalis Capitis at its insertion into the squama of the occipital bone. Cut through the muscle at its insertion, reflect it laterally and clean its slips of origin from the upper thoracic and lower cervical transverse (or articular) processes. Deep to the muscle there is a dense mass of fibro-areolar tissue, traversed by the greater occipital nerve. The **occipital artery** in this, the **suboccipital region,** appears from under cover of the Longissimus Capitis. Its descending branch anastomoses with the **deep cervical branch** of the **costo-cervical trunk,** which ascends between the Semispinalis Capitis and the Semispinalis Cervicis. This anastomosis is usually difficult to demonstrate. Identify the spine of the axis and that of the 7th cervical vertebra (vertebra prominens). The muscle inserted into the cervical spines between these two points is the **Semispinalis Cervicis.** It arises from thoracic transverse and cervical articular processes. Detach this insertion from the cervical spines. The muscle is thin; between it and the underlying **Multifidus,** whose fibres take a shorter span but otherwise run a similar course, there is necessarily a layer of loose areolar tissue. Raise the Multifidus, turn it laterally, and clean its slips of origin. Note the nerves running medially in this plane. Clean the whole Multifidus from above downwards. It extends as high as the spine of the axis and as low as the lower part of the sacrum. Its lower limit therefore cannot be seen until the origin of the Sacrospinalis is reflected. Do this. In the thoracic

region look for one or two of the little *Rotatores* extending from the root of the transverse process to the base of the spine of the vertebra next above. Of the remaining deep muscles, the **Levatores Costarum** are fan-shaped portions of the External Intercostals prolonged upwards and medially to the tips of the transverse processes of the vertebrae next above; the *Interspinales* are paired bands of muscle fibres uniting adjacent vertebral spines, and well developed in the cervical and lumbar regions; the *Intertransversarii* should be left till the prevertebral muscles are dissected.

THE SPINAL CORD. Place a block under the anterior superior iliac spines, to reduce the concavity in the lumbar region. Scrape the remnants of muscles off the dorsal aspect of the vertebrae. Then, remembering that the vertebral canal has a smaller caliber than a finger-ring, with a saw, inclined so that it will enter the vertebral canal, cut through the laminae on each side from the tenth thoracic vertebra to the coccyx; remove the sections of bone between the saw-cuts and save them. Smooth the jagged edges with bone-forceps, pick out fat and clean the **dura mater** of the spinal cord.

After placing a seeker in an intervertebral foramen in order to protect the nerve, remove with bone-forceps the articular processes lying posterior to this foramen and so expose a **posterior root ganglion.** Observe that the dural sheath is continued out along each nerve root as far as the ganglion. Follow for a short distance an **anterior** and a **posterior nerve ramus.**

Slit the dura and arachnoid vertically by the use of forceps and knife. (Notice how readily this is done; obviously the fibers of the dura run vertically.) See the lower limit of the **subarachnoid space,** and determine its level by palpating the posterior superior iliac spines.

Identify the lower end of the **spinal cord** and verify its level. The collection of **dorsal** and **ventral nerve roots** below the lower end of the spinal cord is known as the **cauda equina.** Note it, then single out from among these roots the **filum terminale** and trace it to the back of the coccyx; it is distinguished by its silvery appearance and by the fact that it is continuous with the tapering lower end of the spinal cord, the **conus medullaris.**

In the thoracic region make two transverse cuts 2″ to 3″ apart through the spinal cord and its meninges. Cut the nerve roots of this portion extradurally and as far laterally as possible, then remove the section and examine it. From the inner surface of the dura, examine the region of exit of an anterior and a posterior nerve root. Observe also the **ligamentum denticulatum** stretching laterally across the subarachnoid space to be attached by pointed processes to the dura.

On looking into the opened vertebral canal the **posterior longitudinal ligament** is seen covering the posterior aspect of the bodies of the vertebrae. Cut it across, dissect it up and observe the large veins issuing from the bodies of the vertebrae to form a plexus. Identify an intervertebral disc and note the share it takes in the boundary of an intervertebral foramen.

THE SUBOCCIPITAL REGION. The **Semispinalis Capitis** is the covering muscle or lid of this region. It has been reflected; the dense areolar sheet deep to it has been observed; and the **greater occipital nerve** has been followed through both fascia and muscle. Now follow the nerve to the lower border of the Inferior Oblique round which it turns. The **Obliquus Capitis Inferior** forms the lower limit of the suboccipital region. Its lower border may now safely be

cleaned; it extends medially to the spine of the axis and laterally to the transverse process of the atlas. These two bony landmarks and the posterior tubercle of the atlas must be identified by palpation.

In the suboccipital region are to be found four muscles, two nerves and two arteries. On the RIGHT side (after the greater occipital nerve has been traced to the inferior border of the Inferior Oblique) it may be well to specialize on the 4 muscles and to clean them carefully. The Obliquus Capitis Inferior is thick, fleshy and rounded, and, together with the Obliquus Capitis Superior and the Rectus Capitis Posterior Major which are flat and triangular, it forms the boundaries of a triangle—the suboccipital triangle. The **Obliquus Capitis Superior** bounds the triangle laterally, and runs from the transverse process of the atlas obliquely upwards and medialwards to the squama of the occipital bone lateral to the Semispinalis Capitis. The **Rectus Capitis Posterior Major** bounds the triangle medially, and runs upwards and lateralwards from the spine of the axis. Medial to this again is the **Rectus Capitis Posterior Minor,** which takes no part in the formation of the triangle; it arises from the posterior tubercle of the atlas and is therefore on a deeper plane.

Having cleaned and studied these muscles, clean the **posterior arch of the atlas** and the thin **posterior atlanto-occipital membrane** which unites this arch to the posterior part of the margin of the foramen magnum.

On the LEFT side, begin by tracing a communicating branch from the **greater occipital nerve** across the Inferior Oblique to the **posterior ramus of the suboccipital nerve** (C.1). If this communicating branch is lost, find the nerve to the Rectus Capitis Posterior Major and trace it to the posterior ramus of C.1. This ramus supplies the four muscles of the re-

gion and sends a twig to the muscle covering the region. Having found these, follow the stem of the nerve; this requires the point of the knife. Find the **vertebral artery** winding behind the superior articular process of the atlas; detach the **posterior atlanto-occipital membrane** from the posterior arch of the atlas and follow the vertebral artery in its groove on the arch to where the **posterior ramus of C.1** emerges between it and the arch. Muscular twigs of the artery pass through the triangle and commonly a large vein from the vertebral plexus pierces the membrane to join the suboccipital plexus of veins. The occipital artery has already been seen.

THE INTERIOR OF THE SKULL

THE REMOVAL OF THE SKULL CAP. If not already done, the epicranial aponeurosis should be incised coronally from an inch above one zygomatic arch to the corresponding point on the opposite side. The anterior half of the aponeurosis should then be pulled well down over the face and the posterior half well down over the nuchal region. The temporal fascia and muscle should be scraped downwards off the bone which should be left bare. A piece of string passed round the skull $\frac{1}{2}$ to $\frac{3}{4}$ of an inch above the supra-orbital margin and inion, and pulled tight, enables an encircling pencil-mark to be made on the bone as a guide to the saw-cut. If an iron frame is available, use it. During the sawing of the bone the body must be alternately on the back and face. On the sides of the skull the bone is thin so there is danger of wounding the brain. By using only the "heel" of the saw and making short to and fro movements, the saw can be kept under control and the depth of the cut regulated. As a precaution protect your left hand with a towel. Make a preliminary encircling cut all round, deeper in front and behind than at the sides; then deepen the cut judiciously.

With the chisel in the cut and with strokes of the mallet cause the edges of the cut to gape; if they refuse, renew the sawing over the resisting regions until ultimately you succeed in prising off the skull cap.

[Caution: Do not cut the dura mater. As the saw-cut in the skull opens, push the dura back and peel it off the inner surface of the bones so as to leave it intact. Moist red bone-dust indicates that the cut is into the diploë.]

Notice that the exposed outer surface of the dura is rough for, until disturbed, it is adherent to the cranial bones for which it is a periosteum. Observe, on each side of the median sagittal plane, fungoid masses, **arachnoid granulations**; they are responsible for shallow depressions on the bones with which they are in contact. Look for branches (anterior and posterior) of the **middle meningeal vessels** which ascend in the outer layer of the dura.

In certain situations between two layers of the dura are venous channels, the **cranial venous sinuses.** One of these, the **superior sagittal sinus,** occupies the median sagittal plane. Slit it open and verify as many of the following features as is possible:

1. It increases in calibre as it passes backwards.
2. It is triangular in cross section and in its **lateral recesses** (lacunae laterales) are to be seen the openings of cerebral veins which drain the surfaces of the cerebral hemispheres.
3. The **arachnoid granulations,** already noted, when in place hang free in the lateral recesses.
4. **Middle meningeal veins** communicate with the sinus.
5. An **emissary vein** which pierces the parietal bone connects the sinus to extra-cranial veins.

Incise the dura along each side of the superior sagittal sinus keeping an inch from the median plane so as to avoid

the lateral recesses. Incise the two side portions of the dura coronally from the vertex towards the ear, and turn down the four flaps thus formed. Examine the inner surface of the dura. Observe that it is smooth and glistening and that it is re-duplicated to form (four) inwardly projecting folds, one of which is visible now, occupying the median sagittal plane and separating the two cerebral hemispheres. It is the **falx cerebri.**

Before proceeding further it is essential that the student have some familiarity with the interior of the base of the skull and since this is only acquired after considerable study he is advised to cease dissection for a time and give his attention to the macerated skull. With it beside him he should verify each statement in his text-book, as he reads an account of the interior of the base of the skull, its fossae, foramina, and contents.

Cranial Nerves and Vessels. Sever the **falx cerebri** and the contained superior sagittal sinus just above the **crista galli.** Withdraw the falx cerebri from between the cerebral hemispheres, and, as you do so, note and cut the five or six large cerebral veins which open into the superior sagittal sinus against the blood stream.

Proceed to identify and examine the nerves and vessels as instructed below, and for purposes of subsequent study, cut them long, using scissors—a knife would tear these unsupported structures, especially the nerves which have neither a connective tissue sheath nor a primitive sheath within the dura mater.

Let the head fall back, and gently raise the **frontal lobes** of the brain. On the floor of the anterior cranial fossa, about half a centimetre from the median plane, observe a long (3

cm.), fragile stalk with a slightly enlarged anterior end, the **olfactory tract** and **bulb.** The bulb is fixed to the floor by delicate **olfactory nerves** which descend from it and, in tubes of arachnoid mater, pierce the **cribriform plate** to supply a small area on the roof and walls of the nasal cavity. Cut one olfactory tract far back and so leave the olfactory bulb resting on the cribriform plate; on the other side raise the olfactory tract and bulb with the frontal lobe. Observe the **optic chiasma** lying well behind the optic (chiasmatic) groove, and the **optic nerve** passing on each side to the **optic foramen**: cut the nerves. The **internal carotid artery** ascends in the angle between the **optic tract** and optic nerve. Cut it. Cut the stalk of the **hypophysis cerebri** (pituitary gland) behind the optic chiasma and above the **diaphragma sellae.** Ease the **temporal pole** from under cover of the lesser wing of the sphenoid first on one side then on the other, turning the head from side to side, taking advantage of gravity, and all the time supporting the brain with the palm.

For success in the procedure of cutting through the upper part of the **midbrain** in order that the forebrain may be entirely removed, it is necessary to bear in mind the bell-tent shape of the **tentorium cerebelli** which roofs the posterior cranial fossa. Keeping the blade of the knife above the clinoid processes and letting the cut, as it passes backwards, rise in order to follow the line of the free margin of the tentorium cerebelli, cut through the midbrain and let the forebrain fall away in your hand. On each side the **posterior cerebral artery** will be cut through where it winds round the midbrain, and the **great cerebral vein** will be cut in the median plane behind. The **oculo-motor nerve** (N. III) is large. It enters a cul-de-sac in the triangular field between the attachments of the tentorium to the anterior and posterior clinoid processes. Trace it backwards and medially, past the

posterior clinoid process and between the posterior cerebral artery above the **superior cerebellar artery** below, to the front of the midbrain just above the **pons.** Cut it. The **trochlear nerve** (N. IV), the most delicate of the cranial nerves, pierces the dura in the same triangle as nerve III, but farther back, and it passes between the same two arteries. Follow it backwards around the midbrain under shelter of the free edge of the tentorium, which requires to be raised to bring it into view. Cut it. On both sides cut the free margin of the tentorium cerebelli about its midpoint and carry the incision lateralwards to the attached margin. From the point now reached sever the attached margin backwards along the superior border of the petrous temporal bone and thence to a point near the internal occipital protuberance to which the margin should be left attached. Reflect the flaps so produced. Identify the **trigeminal nerve** (N. V), the largest of the cranial nerves, where it arches over the most medial part of the upper border of the petrous bone below the attached margin of the tentorium. Follow it as it curves backwards and slightly downwards to the side of the pons. Cut it. With the handle of the knife hold the midbrain and pons back from the basi-occipital and looking down identify the **abducent nerve** (N. VI). It arises at the lower border of the pons (between the pyramid and olive) in line with N. III, ascends, clamped to the pons by the **anterior inferior cerebellar artery,** and pierces the dura over the inferior petrosal sinus. Cut it. The **facial** (N. VII) and **auditory** (N. VIII) **nerves,** with the *nervus intermedius* between them, arise at the lower border of the pons, abreast of N. VI and almost in line with N. V. They pass laterally and slightly upwards into the internal auditory canal. The **internal auditory artery,** a slender branch of the anterior inferior cerebellar, accompanies them, and the internal auditory vein

ends in the inferior petrosal sinus. Cut them. The **glosso-pharyngeal** (N. IX), **vagus** (N. X), and **accessory** (N. XI) **nerves** arise from the **medulla** and **spinal cord** behind the **olive,** just below and in line with the NN. VII and VIII. They pass laterally across the tuberculum jugulare, pierce the dura mater half-an-inch below the internal auditory meatus, and enter the **jugular foramen** between the inferior petrosal and sigmoid sinuses. Nerve IX runs horizontally and pierces the dura independently in front of NN. X and XI. The root fila of NN. X and XI ascend with increasing degrees of obliquity and pierce together. Nerve XI grooves the tuberculum jugulare. The **hypoglossal nerve** (N. XII) arises from the medulla between the **pyramid** and olive in line with the **anterior root of the first cervical nerve** below. Its root fila, like those of the anterior or motor root of a spinal nerve, converge laterally, and they pierce the dura through two apertures, and enter the **anterior condylar (hypoglossal) canal.** Cut them.

With a long scalpel inserted through the **foramen magnum** cut across the spinal cord (medulla) with one sweep. With it the **vertebral artery** and the **spinal root of the accessory nerve** on each side will be severed. Remove the midbrain and the hindbrain (i.e., pons, medulla and cerebellum). Observe the groove on the cerebellum caused by the margin of the foramen magnum. This no doubt is not present during life when the brain floats in **cerebro-spinal fluid.**

Venous Sinuses. Identify the following venous sinuses and slit them all open with the exception of the cavernous sinus: observe the connexions each makes and verify the statements made below.

1. The **superior sagittal sinus,** already opened, begins at the foramen cecum between the frontal and ethmoid

bones and ends at the **internal occipital protuberance** by turning laterally as the **right transverse sinus.** Sometimes it becomes the left transverse sinus or it may enter a pool of blood at the protuberance, the **confluence of the sinuses,** common to all three. Its tributaries and arachnoid granulations have been noted.

2. The **inferior sagittal sinus** is the venous channel occupying the lower free edge of the falx cerebri. Where the free edge meets the tentorium cerebelli the sinus is joined by the **great cerebral vein** from the interior of the brain and becomes the **straight sinus.**
3. The **straight sinus** occupies the line along which the falx cerebri is attached to the tentorium cerebelli, and at the internal occipital protuberance usually becomes the **left transverse sinus.**
4. Each **transverse sinus** runs forwards in the attached border of the tentorium cerebelli grooving the occipital bone. It crosses the lateral angle of the occipital bone then, having crossed and grooved the postero-inferior angle of the parietal bone, it leaves the attached border of the tentorium, as the **sigmoid sinus,** to run downwards and forwards along the mastoid portion of the temporal bone and across the jugular process of the occipital bone. It leaves the skull at the **jugular foramen** and becomes the **internal jugular vein.**
5. The **superior petrosal sinus** runs along the upper border of the petrous temporal bone in the attached margin of the tentorium cerebelli. It connects the **cavernous sinus** to the transverse sinus. Notice that the superior petrosal sinus bridges NN. V and VI.
6. The **cavernous sinus** is large and important. It is not to be opened now for important structures run through it. It lies on the side of the body of the sphenoid and

will be studied later. Notice now that it drains partly into the superior but chiefly into the inferior petrosal sinus. It is joined to its fellow of the opposite size by **intercavernous sinuses** surrounding the hypophysis.

7. The **inferior petrosal sinus** occupies the groove behind the suture between the basi-occipital and petrous bones. It passes through the jugular foramen to join the internal jugular vein outside the skull. N. VI skirts or passes through it.
8. The *spheno-parietal sinus* is a small sinus lying under shelter of the lesser wing of the sphenoid. It connects the middle meningeal vein to the cavernous sinus.
9. The **basilar sinus** is an irregular venous channel on the dorsum sellae and basi-occiput. It unites the cavernous and inferior petrosal sinuses of opposite sides.
10. The *occipital sinus* is a variable sinus partially encircling the foramen magnum having descended in the little falx cerebelli. It ends in the sigmoid sinus.

The Middle Cranial Fossa and Its Contents. Identify the cut ends of NN. II, III, IV, V, and VI. With the seeker and touches of the knife follow **N. IV** forwards, by slitting the dura along its horizontal course, to a point about ½″ in front of the anterior clinoid process. (If this delicate nerve has been broken, at least the orifice where it pierced the dura can be seen and the nerve found in its canal in the dura.)

Pick up the cut end of **N. V** in the posterior cranial fossa where it rounds the superior border of the petrous bone below the tentorium to enter the arachnoid-lined cave, **trigeminal cave,** in the middle cranial fossa. Slit the roof of the cave with scissors and snip it away. In doing this, you will of course cut across the superior petrosal sinus. The cave extends forwards for ½″ or more. Explore its

limits. The parallel fibers of N. V become a loosely woven plexiform swelling, the **trigeminal (semilunar) ganglion.** Remove the dura from the greater wing of the sphenoid for another $\frac{1}{2}''$ in front of the roof of the cave. It is the lateral side and front of the ganglion that you must first free. Trace forwards the **mandibular nerve** (V^3) to the foramen ovale, and the **maxillary nerve** (V^2) to the foramen rotundum. Remove the layer of dura between the trochlear and trigeminal nerves, and follow forwards the **ophthalmic nerve** (V^1) to where it divides into a **frontal** and a **lacrimal** branch. Raise the trigeminal nerve (V) and ganglion from their bed, turn them forwards and see a compact bundle (about the size of N. III), the **motor root of N. V.** Free it from the under surface of the ganglion, which it crosses diagonally, and trace it to the medial end of the **foramen ovale.** Notice some blood-clot extending as far laterally as the ganglion and N. V^2; this clot occupies the lateral limit of the cavernous sinus; pick it away and identify the **naso-ciliary** branch coming off the medial aspect of N. V^1. It is a very delicate nerve.

Trace the **oculomotor nerve** (III) forwards by slitting the dura of its minature "cave". Note its close relation to the anterior and posterior clinoid processes.

Pick up the **abducent nerve** (VI) and trace in similar fashion: (a) its ascending portion in the posterior cranial fossa and (b) its horizontal portion in the middle fossa. Note its intimate relation to the apex of the petrous bone and to the internal carotid artery.

Clean the **internal carotid artery** and note its relations. By pricking with the point of the knife the roof of the terminal part of the carotid canal, demonstrate the nature (fibrous or osseous) of the bed of the trigeminal cave.

At the pterion, strip the dura medially and observe whether the anterior branch of the **middle meningeal artery** goes

limits. The parallel fibers of N. V become a loosely woven plexiform swelling, the **trigeminal (semilunar) ganglion.** Remove the dura from the greater wing of the sphenoid for another ½″ in front of the roof of the cave. It is the lateral side and front of the ganglion that you must first free. Trace forwards the **mandibular nerve** (V^3) to the foramen ovale, and the **maxillary nerve** (V^2) to the foramen rotundum. Remove the layer of dura between the trochlear and trigeminal nerves, and follow forwards the **ophthalmic nerve** (V^1) to where it divides into a **frontal** and a **lacrimal** branch. Raise the trigeminal nerve (V) and ganglion from their bed, turn them forwards and see a compact bundle (about the size of N. III), the **motor root of N. V.** Free it from the under surface of the ganglion, which it crosses diagonally, and trace it to the medial end of the **foramen ovale.** Notice some blood-clot extending as far laterally as the ganglion and N. V^2; this clot occupies the lateral limit of the cavernous sinus; pick it away and identify the **naso-ciliary** branch coming off the medial aspect of N. V^1. It is a very delicate nerve.

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At the pterion, strip the dura medially and observe whether the anterior branch of the **middle meningeal artery** goes

through a canal or a groove in the parietal bone. Notice the artery adheres to the outer surface of the dura.

The *greater* and *lesser superficial petrosal nerves* run parallel to one another and to the superior border of the petrous bone. The greater lies $\frac{1}{2}''$, the lesser $\frac{3}{4}''$, in front of that border. In order to find them make an antero-posterior cut one inch long through the dura covering the arcuate eminence, and another along the superior border of the petrous bone. (The latter cut may have been made already if the superior petrosal sinus was slit open.) Raise the flap so that it may be peeled off the two nerves whose foramina of exit from the petrous bone face medially. Define these nerves (using the point of the knife) and follow the greater to the foramen lacerum, the lesser to the foramen ovale. Both are accompanied by twigs of the middle meningeal artery.

Now dissect forwards the dura till the stem of the **middle meningeal artery** is exposed entering the middle cranial fossa through the foramen spinosum.

Observe the **optic chiasma** is flat and lies well behind the optic groove of the body of the sphenoid. The **hypophysis cerebri** (pituitary gland) lies beneath the **diaphragma sellae.** With the seeker define the circular aperture of the diaphragm, enlarge it and scoop out the hypophysis. Observe the vascular (venous) bed in which it lay.

THE ORBITAL CAVITY AND CONTENTS

The orbital cavity in the human is a very deep socket resulting from the enormous growth forward of the brain. It is, in fact, as much a part of the floor of the cranium (and the 'roof' of the face) as it is the socket for the eyeball. As a consequence, there are to be found within it, not only the eyeball and its related structures, but also vessels and nerves

making their way through the cavity in close contact with the roof or floor and destined for the scalp and face.

Before dissection begins, the student needs to familiarize himself with the walls of the orbit and the bones which form them and he will do well to appreciate the following additional points:

1. The **optic foramen** (canal) situated at the apex of the cavity is at the junction of the roof and medial wall. Through it pass only the **optic nerve** with its coverings and the **ophthalmic artery.**
2. Just lateral to the optic foramen is the **superior orbital fissure** through whose medial end pass all other structures entering the cavity. (The outer part of the fissure is closed by a fibrous membrane.)
3. Implanted on the bones adjacent to and surrounding both openings, is a tough fibrous ring or cuff. From this cuff as an apex six muscles diverge to be inserted into the eyeball for its movements. As a result a cone of muscles passes forwards from the cuff to the eyeball.
4. Nearly all structures destined for the eyeball or its muscles enter the cavity within the cone of muscles; whereas nearly all those destined for parts beyond enter without, i.e., through the superior orbital fissure above or below the fibrous cuff.

The LEFT ORBIT ONLY is to be dissected from above. With chisel and mallet make a hole through the roof of the orbit. The bone may be thin or somewhat thick; it is hollow in front owing to the existence of an air sinus, the **frontal sinus,** and it may similarly be hollow medially where **ethmoidal air cells** may project into the medial part. With bone forceps nibble away the whole roof (to within about $\frac{3}{4}''$ of the midline), but anteriorly save the orbital margin. The **periorbita** (i.e.,

the lining periosteum) does not adhere to bone, so there is little danger of injuring it. Run the seeker, between the periorbita and the roof, backwards through the **superior orbital fissure.** Remove the roof of the fissure. With the seeker and scissors cut away the periorbita but only as far posteriorly as it is free, lest the delicate **trochlear** and **lacrimal nerves,** which enter one on each side of the **frontal nerve,** be torn.

In the midline of the orbital cavity immediately beneath the periorbita the **frontal nerve** is seen running forwards and the muscle it is resting on is the **Levator Palpebrae Superioris.** Trace the frontal nerve forwards to its division into **supra-orbital** and **supra-trochlear nerves.** The **lacrimal nerve,** smaller than the frontal and lying in contact with its lateral side as it enters the orbit, is to be traced forwards to the **lacrimal gland.** Arteries accompany the frontal and lacrimal nerves. Pick out the lobules of fat observed and subsequently remove fat as it is encountered. The **trochlear nerve** lies in such intimate contact with the medial side of the frontal nerve as to be easily mistaken for a branch. It is small and crosses the origin of the Levator Palpebrae Superioris as it leaves the frontal nerve to pass forwards and medially to enter the upper surface of the **Superior Oblique,** the muscle occupying the angle between roof and medial wall. The trochlear nerve supplies the Superior Oblique far back.

Examine the **Levator Palpebrae Superioris.** Cut the muscle well back and throw it forwards; its nerve which enters its deep surface will of necessity be destroyed. Re-examine the lateral expansions of the tendon as the **check ligaments.** The muscle lying deep to the Levator and now exposed is the **Superior Rectus.** Clean it, then cut and reflect it, observing the **superior division of the oculomotor nerve** (N. III) entering its deep surface. The nerve pierces the muscle to reach the overlying Levator. Examine the **Superior Oblique**

muscle already identified as lying in the angle between the orbital roof and medial wall. Its nerve (trochlear N. IV) has been traced. Trace the muscle forwards to its **trochlea** or pulley. The tendon there turns backwards and lateralwards passing beneath the **Superior Rectus** to its insertion.

The muscle lying along the medial wall immediately below the Superior Oblique is the **Medial Rectus.** Do not disturb it now but, between it and the Superior Oblique, find the **naso-ciliary nerve.** Look for a twig of the nerve entering the **posterior ethmoidal foramen** to supply the **posterior ethmoidal air cells.** Trace the nerve forwards and identify its (larger) **anterior ethmoidal branch** leaving the orbit through the anterior ethmoidal foramen and its **infratrochlear branch** running, of course, below the trochlea of the Superior Oblique. Trace the naso-ciliary nerve backwards and find the **two long ciliary nerves** leaving it to run to the eyeball. As the nerve is traced further back, it crosses above the **optic nerve.** Leave it here and look on the lateral side of the optic nerve, and in apposition with it, for the **ciliary ganglion.** It is flat and star-shaped; it may be distinguished from the fat by its brownish color and by the **short ciliary nerves** that run forwards from it to the back of the globe. Having identified the optic nerve, notice it is crossed also by an **ophthalmic vein** and by the **ophthalmic artery.** This artery lies at first below the optic nerve; it soon appears on the lateral side of the nerve where it gives off the **lacrimal artery** which supplies the lateral contents of the orbit and anastomoses with the middle meningeal artery. Follow the ophthalmic artery medially in company with the naso-ciliary nerve, and identify its *dorsal nasal branch* accompanying the infratrochlear nerve.

Read an account of the branches and distribution of the **ophthalmic artery** and identify the main branches but do not

delay over the smaller ones. Snip away the roof of the optic canal (foramen), and then pass a straight probe along the whole extent of the **sheath** of the **optic nerve** and open the sheath along the probe. Cut the **optic nerve** inside the sheath just behind the eyeball and lift it up. In doing this, you will be able to see the **central artery of the retina,** given off from the ophthalmic artery whilst that vessel is still below the optic nerve and entering the nerve, after piercing the sheath, about $\frac{1}{3}''$ behind the eyeball. Free the optic nerve and observe it is adherent to its sheath only in the region of the roof of the optic canal. Break this connection and entirely withdraw the nerve. It will still retain its sinuous outline. Cut it across and you will readily see a central dark spot marking the central artery.

The short ciliary nerves in the above procedure were doubtless destroyed. If now the sheath of the optic nerve be removed, you will see the **Inferior Rectus** and, if the posterior pole of the globe be raised, the **Inferior Oblique,** which crosses below the Inferior Rectus, will come in to view. The origin of the Inferior Oblique can be displayed best from the face, after cutting through the palpebral fascia along the inferior orbital margin. From its origin lateral to the lacrimal sac, it crosses below the Inferior Rectus. The **Medial Rectus,** as well as the Inferior Rectus and the Inferior Oblique, is supplied by the inferior division of the oculomotor nerve. This division is most readily found by picking up the branch to the Inferior Oblique lying along the lateral border of the Inferior Rectus. On tracing this branch backwards, the branch to the Inferior Rectus is found and, behind that again, the branch to the Medial Rectus is seen crossing above the Inferior Rectus near its origin.

Examine the **Lateral Rectus** running along the lateral wall of the orbit. Its nerve, the **abducent nerve** (N. VI) clings

to it, enters it behind its midpoint, and must be found. Lateral to the Lateral Rectus lies the periorbita. On the wall look for a connecting branch which the zygomatic nerve gives to the lacrimal. Do not delay long over this.

Observe that the insertions of the four Recti muscles are by thin wide tendons into the outer coat of the eyeball, the **sclera,** near the cornea; and that the insertions of the two Obliques are also by thin wide tendons but into the sclera of the posterior half of the globe. Read an account of the attachments and actions of these muscles.

Finally trace the continuity of the nerves from the middle cranial fossa to the orbital cavity.

The Right Orbit is to be dissected from the facial aspect, without cutting or removing any bone, this being the surgical approach. Note the following points and where necessary carry out the dissection indicated to verify them:

1. The **conjunctiva** is fortunately adherent to the cornea, but movable over the sclera.
2. An incision through the conjunctiva 6–8 mm. behind the **corneo-sclerotic junction** permits a hook to grasp in turn the tendons of the four Recti. This procedure is facilitated if the lids are first cut away and the palpebral fascia removed.
3. Just within the four corners of the orbital margin some feature worthy of attention is to be found:

   Upper lateral—the lacrimal gland.

   Upper medial—the pulley for the Superior Oblique.

   Lower medial—the origin of the Inferior Oblique and the lacrimal sac.

   Lower lateral—the inferior orbital fissure.
4. The Superior and Inferior Obliques, if followed to their insertions, will be found to pass below the corresponding Recti.

5. If the Inferior Rectus and the globe be pressed upwards, the nerve to the Inferior Oblique can be seen entering the posterior border of its muscle after coursing along the lateral border of the Inferior Rectus.
6. The lateral edge of the Levator Palpebrae Superioris causes the lacrimal gland to assume a horseshoe shape; one part lying above it, the other below it. The lateral edge, which is easily found, should be traced to the zygomatic bone where, with the attachment of the lateral palpebral raphe, it creates a tubercle. This attached edge acts as a check ligament.

The right eyeball is to be removed and the structures requiring to be cut to accomplish this are to be noted. Hook up each Rectus tendon in turn and cut it across; adduct the eyeball and, pulling it forwards, with curved scissors cut across the optic nerve from the lateral side; the eyeball can now be pulled out of the cavity and, after the two oblique muscles are cut across, it can be completely removed. Study the socket. Pick up the nerve to the Inferior Oblique and follow it backwards as far as possible, noting that the nerves to the Inferior Rectus and Medial Rectus spring from it, as does the motor branch to the ciliary ganglion. Pick up also the nerve to the Superior Rectus and Levator Palpebrae Superioris and the nerve to the Lateral Rectus; the trochlear nerve is remote. Trace the muscles to their origins, and finally, without damaging the orbital margin, trace backwards the infra-orbital vessels and nerves.

THE ANTERIOR TRIANGLE OF THE NECK

This region has been, very properly, regarded as a cavity, the **'cervical cavity'**, comparable to the abdominal cavity. It is bounded behind by the bodies of the cervical vertebrae and laterally by the **Scalene muscles** (the developmental counterparts of the Oblique muscles of the abdominal wall) which

descends from cervical tubercles to the first (and second) rib. In front, the cavity is enclosed by strap-like muscles, about 1″ wide and lying on either side of the midline, which extend from the sternum below to the thyroid cartilage and hyoid bone above (c.f. Rectus Abdominis). Below, the cavity is continuous with that of the thorax within the circumference of the first rib.

The cervical cavity houses, as **'cervical viscera'**, the upper parts of the digestive tract (**pharynx** and **esophagus**) and the upper parts of the respiratory tract (**larynx** and **trachea**): in front of these tubes is the **thyroid gland.** These all lie in the midline in front of the bodies of the cervical vertebrae whilst on either side of them, and therefore in front of the transverse processes, the great vessels (**carotid arteries** and **internal jugular vein**) and the **vagus nerve** ascend and descend wrapped in the fascial **carotid sheath.**

The **external carotid artery** is destined for the supply of practically everything in the head and neck outside the skull, whilst the **internal carotid artery** devotes itself entirely to the structures within the cranial and orbital cavities. Since the external carotid artery arises relatively high up in the neck, the **subclavian artery,** as it runs across the root of the neck, is also called upon to contribute blood to the lower half of the neck. Another of its branches, the **vertebral artery,** ascends within the transverse processes to enter the skull via the foramen magnum and aids in the supply of the brain.

Remove entirely the skin from the front of the neck. Complete the study of the **Platysma.** Reflect and remove it. Read and study the deep fascia, superficial veins and nerves. The nerves are: (1) the **anterior cutaneous,** (2) the **cervical branch of the facial** and (3) the **great auricular.** These have been identified and in part traced already. Incise the deep

fascia vertically just above the sternum in order to see that it splits here to form the **suprasternal space.** Now trace the **anterior jugular vein** (which is small and near the median plane) to the suprasternal space, and follow it deep to the Sternomastoid along the upper border of the clavicle to the external jugular vein in the posterior triangle. Trace the **anterior facial vein** along the lower border of the jaw until it joins a vein, the **anterior branch of the posterior facial vein,** which emerges from the parotid gland to form the **common facial vein.** (This last is sometimes joined to the anterior jugular vein by a connecting branch which runs along the anterior border of the Sternomastoid.) Trace the common facial vein to where it pierces the deep fascia, but no farther. Clean the deep fascia within the confines of the triangle.

Identify, from above downwards, the following structures in THE MEDIAN LINE OF THE NECK:

1. **Mylohyoids,** meeting in a midline raphe and occasionally hidden from view by the fusion of the two **anterior bellies** of the **Digastrics.** Usually the anterior bellies of the Digastrics diverge below to form the lateral limits of the little **submental triangle** floored by the Mylohyoids.
2. **Hyoid bone.**
3. **Thyrohyoid membrane,** uniting the upper border of the hyoid bone to the upper border of the:
4. **Thyroid cartilage.**
5. **Median cricothyroid ligament,** uniting the lower border of the thyroid cartilage to the upper border of the **cricoid cartilage.** It is visible between the two **Crico-thyroid muscles** which unite the two cartilages more laterally.

6. **Cricoid cartilage.**

7. **Trachea,** crossed by the **isthmus** of the **thyroid gland.**

The vessels also found in the midline will be dealt with as they are followed from their sources. They are neither large nor particularly significant.

Incise the deep fascia in the midline and reflect it laterally for an inch or so. Define the medial borders of the **anterior belly** of the **Digastric,** the **Sternohyoid** and the **Sternothyroid.** The last is overlapped above by the Sternohyoid. Identify the **superior belly** of the **Omohyoid,** lying lateral to the Sternohyoid, and, by retracting the medial border of the Sternohyoid, identify the **Thyrohyoid.** In every case the names of these muscles are sufficiently descriptive of their attachments for them to be recognized without trouble.

THE NERVES IN THE ANTERIOR TRIANGLE. About 2″ below the tip of the mastoid process define the anterior border of the **Sternomastoid.** Working up and down for an inch each way, within the sheath of the muscle, with the seeker and knife, and by retracting the border, it is easy to pick up the **accessory nerve** (N. XI). It is accompanied below by the *sternomastoid branch* of the occipital artery. Be sure now to clean thoroughly the anterior border of the Sternomastoid right up to the mastoid process. The nerve runs downwards and backwards to enter the deep surface of the muscle. You will probably find lymph glands along the nerve. Trace the nerve upwards across the front of the **internal jugular vein** to the lower border of the posterior belly of the Digastric, or, if it disappears behind the internal jugular vein, trace it to that point. (Its relation to the vein is variable.) Follow the **common facial vein** to the internal jugular vein which is lateral to the **internal carotid artery.** This in turn is here lateral to the external carotid artery.

To find the **hypoglossal nerve** steady the hyoid bone with one hand; feel with a finger the tip of the greater cornu; then pick up the nerve just above the tip. At this point the nerve gives off the **nerve to the Thyrohyoid.** This branch crosses the tip of the greater cornu to enter at once the lateral aspect of its muscle. It, and the **descendens hypoglossi**—the only two branches given off in the triangle—come from the lower border, or convexity, of the hypoglossal nerve, which should be cleaned therefore from its concavity. Trace backwards the hypoglossal nerve to where it appears from under cover of the posterior belly of the Digastric, and forwards to where it disappears under cover of the anterior belly. It hooks round the occipital artery. Where that vessel gives off its sterno-mastoid branch, find the **descendens hypoglossi.** Trace this branch down to a loop, the **ansa hypoglossi,** and trace the ansa up, as the **descendens cervicalis** (descending branch of C.2 and 3), all the time keeping to the concavity of the loop in order not to damage the twigs to the infrahyoid muscles, which radiate from the convexity. Clean now the infrahyoid muscles, preserving their nerves which approach them from their lateral sides.

Pull the internal jugular vein and N. XI laterally, and the carotid arteries and N. XII medially. This will expose the **vagus nerve** (N. X), somewhat larger than N. XI, descending vertically between the vein and arteries. Trace it down within the fascial tube, the **carotid sheath,** common to these three structures.

Now find the internal laryngeal and the external laryngeal branch of the **superior laryngeal nerve.** Proceed as follows: relax the structures by bending the head forwards and using a block; steady the opposite side of the hyoid bone, locate the greater horn of the hyoid and the superior horn of the thyroid cartilage; then, working with a seeker in the interval between

them, find the **internal laryngeal nerve** running downwards and forwards and passing under shelter of the posterior border of the Thyrohyoid. It is a substantial sensory nerve. It pierces the thyrohoid membrane in several branches above its companion vessels (the internal laryngeal artery and vein from the superior thyroid). The **external laryngeal nerve** is a long slender motor nerve which supplies the Crico-thyroid and the adjacent part of the Inferior Constrictor of which the Cricothyroid is the partially detached anterior portion. The nerve leaves the superior laryngeal nerve high up. Pull the carotid sheath laterally and find this delicate thread close between the carotid sheath and the fascia covering the Inferior Constrictor. Alternatively, pull the Omohyoid medially, find the attachment of the Sternothyroid to the oblique line of the thyroid cartilage, raise the latter muscle and find the nerve passing deep to it along the upper border of the superior thyroid artery. Trace the nerve through a few fleshy fibers of the Inferior Constrictor to the **Cricothyroid.** If the thyroid gland is enlarged upwards, the artery may be forced above the nerve.

The **sympathetic trunk** (about the size of the phrenic nerve) lies close behind the common and internal carotid arteries, but outside the carotid sheath; it is medial to and smaller than the vagus, which occupies the posterior angle between the carotid arteries and the internal jugular vein inside the sheath. Identify the trunk but do not clean it yet.

THE VESSELS IN THE ANTERIOR TRIANGLE. *The sternomastoid branch of the occipital artery* (which follows the lower border of the accessory nerve) and the *sternomastoid branch of the superior thyroid artery* (which follows the upper border of the Omohyoid) have probably been broken or cut. The common facial vein has been followed to the internal jugular

vein at the level of the hyoid bone. The **middle thyroid vein** enters the internal jugular close above the Omohyoid. The **superior thyroid vein** follows its artery and enters the internal jugular higher up. The **lingual vein** enters still higher. A **pharyngeal vein** descends from under cover of the posterior belly of the Digastric to enter the internal jugular vein, or to join the common facial. Verify these facts, and then, if the veins are impeding your progress, remove them.

The **carotid sheath** should be cleaned as the dissection proceeds. The **common** and **internal carotid arteries** lie in medial contact with the internal jugular vein and have no collateral branches. The common carotid divides about the level of the upper border of the thyroid cartilage into its two terminal branches, the internal carotid and the external carotid. Notice here the swelling called the **carotid sinus.** The **external carotid artery,** the smaller branch, lies antero-medial to the internal carotid and gives off six vessels before reaching the upper border of the posterior belly of the Digastric. Identify them:

1. **Superior thyroid,** arising just below the tip of the greater cornu of the hyoid bone and descending medially to the apex of the thyroid gland; it has *infrahyoid,* **superior laryngeal** (accompanying the internal laryngeal nerve), *sterno-mastoid,* *crico-thyroid,* and **glandular** branches. All of these are easily found and should be identified.
2. **Lingual,** arising opposite the tip of the greater cornu of the hyoid bone and quickly disappearing from sight. Its small *suprahyoid branch* can be seen now, but the chief distribution of the vessel is at present inaccessible.
3. **Facial** (external maxillary), arising just above the tip of the greater cornu of the hyoid bone. Its course from its origin to the point where it enters the face will be dealt

with in a moment. Its course and distribution in the face were investigated earlier.

4. **Occipital,** and 5, **posterior auricular,** arising from the posterior aspect of the parent stem and passing backwards superficial to the internal jugular vein and deep to the posterior belly of the Digastric. They may be too high up to be accessible now and in any case will be seen later.
6. **Ascending pharyngeal,** a long slender vessel, usually the first branch to arise and, as its name implies, running up the pharyngeal wall to supply it. Unless the subject is well-injected it may not be easy to find.

The Digastric Triangle and the Submandibular (Submaxillary) Region. The upper part of the neck is complicated by the presence of structures derived from branchial arches. These arches may be likened to cartilaginous bows swinging across the neck from points on the skull on one side to comparable points on the other. Thus the **first arch** ran between the two spines of the sphenoid, and when, by ossification, it became markedly broadened to produce the **mandible** the resulting bone and the muscles of mastication attached to it, overhung and hid from view the structures in the upper part of the neck.

Similarly the **second arch** ran between the two **styloid processes** and included, besides these processes, the stylohyoid ligaments and the lesser cornua of the hyoid bone. Two of the muscles associated with this arch, the Stylohyoid and the posterior belly of the Digastric, in similar fashion swung across the neck still further to obscure its upper portion. If these facts are borne in mind it is easy to appreciate why, in the upper part of the neck, a digastric triangle exists overshadowed by a submandibular region.

The cervical branch of the facial nerve has been displayed. The common facial vein has been traced to its termination. Retract the anterior border of the **submandibular** (submaxillary) **salivary gland** which fills the triangle, in order to see and follow the **mylohyoid nerve.** Its course is almost horizontal and, even with the head retracted, it is still sheltered by the lower border of the mandible. It passes on the Mylohyoid to the anterior belly of the Digastric and supplies both. The *submental branch* of the facial artery accompanies this nerve and may be followed across the lower border of the jaw on to the face.

Separate the posterior part of the submandibular gland from under shelter of the jaw and pull this part forwards away from the stout fascia that posteriorly separates it from the parotid gland. This fascial thickening is the *stylo-mandibular ligament.* Raise the gland from the Digastric below, and note that the **Stylohyoid** muscle, which in appearance resembles a Lumbrical, lies along the upper border of the Digastric and splits to let the intermediate tendon of the Digastric pass through it. Follow the **facial artery** up the cleft on the deep surface of the gland; free it from the cleft and remove the superficial part of the gland by cutting it through with scissors.

The **hypoglossal nerve** and the **lingual artery** have been identified in the carotid triangle, where the nerve crossed the artery superficially; trace them forwards to the digastric triangle. Just above the tip of the greater cornu of the hyoid bone, nerve and artery reach the posterior free border of the **Hyoglossus** muscle which arises from the length of the greater cornu. The lingual artery, after giving off its small *supra-hyoid branch* which anastomoses with its fellow across the midline, passes out of sight deep to the Hyoglossus. The hypoglossal nerve, accompanied by a vein, courses forwards

across the superficial surface of the Hyoglossus and disappears from sight deep to the free posterior border of the Mylohyoid.

Clean the presenting parts of the **Mylohyoid** and **Hyoglossus** and define their free posterior borders. Observe any lymph glands in the region. Note that the deep part of the **submandibular gland** and its **duct** pass deep to the posterior border of the Mylohyoid and so enter the mouth.

THE ROOT OF THE NECK. Cut the Sternomastoid about its middle and turn the lower half down. Trace the **anterior jugular vein,** applied to the upper border of the clavicle, to its termination in the external jugular vein. Cut the Sternohyoid and Sternothyroid between their upper and lower nerve supplies and turn them up and down. Remove the sheet of fascia that binds the posterior belly of the Omohyoid to the back of the clavicle. The **thyroid gland** lies exposed, extending between the carotid sheaths of the two sides, across the front of the trachea. Put a block behind the head to relax the structures at the root of the neck. Opening in the angle between the left subclavian and left internal jugular veins is the thin-walled **thoracic duct;** it is about the same size as the superior thyroid artery; it may contain venous blood in its terminal $\frac{1}{2}''$ and therefore be mistaken for a vein; otherwise it is pale, collapsed and of irregular caliber. Working with two pairs of blunt forceps find the duct in the angle; then, holding the carotid sheath forwards, follow its arched course medially, observing that it passes behind the sheath, that it tends to adhere to the sheath, and that no structure intervenes between it and the sheath.

Remove the remains of the carotid sheath. Cut the common carotid artery near the clavicle; turn it up and fix it there. Clean the **vagus nerve.** Clean the **phrenic nerve,**

noticing that it lies behind the carpet of fascia covering the Scalenus Anterior, and that it is held down to the muscle by the **transverse cervical** and **suprascapular arteries.** Trace these two arteries back to their origin from the **thyrocervical trunk,** which arises near the medial border of the Scalenus Anterior, and trace the third branch of this trunk, the S-shaped **inferior thyroid artery,** to the thyroid gland. It is well, in conjunction with this last procedure, to trace the **sympathetic trunk** down to where it splits to encircle the inferior thyroid artery. Here find on the sympathetic trunk the **middle cervical ganglion,** detectable as a very small, brownish enlargement.

Opposite the origin of the thyrocervical trunk notice the origin of the **internal mammary artery**; the vessel descends on the pleura. The **vertebral artery,** the first branch of the subclavian, is in part concealed by the **vertebral vein,** which should be removed. Follow the vertebral artery to where it enters its foramen in the transverse process of the sixth cervical vertebra. Here define the medial edge of the **Scalenus Anterior** descending laterally and the lateral edge of **Longus Cervicis** descending medially. These two muscles form two sides of the **'triangle of the vertebral artery'**, whose base is the 1st part of the subclavian artery and whose apex is the transverse process of vertebra C.6. The posterior wall of the triangle includes the transverse process of C.7 and the neck of the first rib as well as the anterior ramus of C.8 and the dome of the pleura. The anterior wall is the carotid sheath. Within the triangle are found the vertebral artery and vein, the inferior thyroid artery, the sympathetic trunk and its middle and inferior cervical ganglia and the thoracic duct. Verify these statements and notice that the sympathetic trunk splits to embrace, first the inferior thyroid artery, then the vertebral artery, then the subclavian

artery. The two ganglia are found, the middle in front of, the inferior behind, the vertebral artery. The inferior ganglion is usually continuous with the first thoracic ganglion situated on the neck of the first rib and together they are known as the **stellate ganglion.**

Read an account of the **thyroid gland.** Cut the isthmus and turn the lobes laterally. Define and then sever the strong ligamentous band which attaches the gland to the first tracheal ring. This allows you still further to separate the gland from the trachea. With the seeker display the **recurrent laryngeal nerve** ascending on the side of the trachea immediately in front of the projecting border of the esophagus, and determine its relation to the branches of the inferior thyroid artery.

With a skull beside him the student should now read an account of the NORMA LATERALIS or lateral aspect of the skull. When he is familiar with it he may proceed to the dissection of the parotid, temporal and masseteric regions.

THE PAROTID REGION

The restricted space occupied by the **parotid gland** can readily be identified on the skull. Identify the **styloid process** and the posterior border of the **ramus of the mandible.** Visualize a loose sheet of fascia extending between these two bony structures, and the depth or 'bottom' of the space will be recognized. The lowest limit of the fascial sheet is thickened so as to be almost worthy of its name, the *stylo-mandibular ligament.* Deep (medial) to the sheet lie the great vessels and nerves applied to the side wall of the pharynx.

The posterior wall of the space extends between the **mastoid** and **styloid processes,** consequently, the muscles attached

to these processes bear intimate relations to the back of the gland. The anterior wall is the posterior border of the ramus of the mandible and the two muscles (Masseter and Medial Pterygoid), one on each side, which clothe the ramus. The space is limited above by the floor of the **external auditory meatus.**

The gland, being too large for the space, 'overflows' these boundaries and the resulting portions of the gland are known as its *processes*. Important vessels and nerves run through the gland and, with it, are to be investigated now.

Note the superficial extent of the **parotid gland** on the face and observe the structures radiating from its margins: of these, the **parotid duct,** the **transverse facial artery** and the **branches of the facial nerve** have already been cleaned; the *posterior auricular artery* and the *posterior auricular branch of the facial nerve*, which pass backwards across the mastoid process just below the cartilage of the ear, are now to be traced. Trace also branches of the *great auricular nerve* through the gland on to the face and others into the substance of the gland where they join the facial nerve. Note any lymph glands superficial to the parotid gland or within its substance. Proceed to find the **stem of the facial nerve.** It emerges from the **stylomastoid foramen,** which is at the level of the lower border of the tragus. After emerging, it descends for $\frac{1}{2}''$ before entering the sheath of the parotid gland. Therefore, with the handle of the knife, ease the gland in its sheath well forwards from the mastoid process; run the handle upwards and it will catch in the angle between the VII nerve stem and the mastoid; stroke downwards and forwards and reveal the nerve before it enters the parotid sheath. Save the branch to the Digastric and Stylohyoid, which comes off the deep surface of the nerve stem and lies on the bed or mould

of the gland, and consequently is not in danger. Save also the posterior auricular artery and its stylomastoid branch.

Trace backwards the branch of the **facial nerve** that crosses the zygoma, and, while doing so, keep close to the upper border of the nerve. At the same time you should define the upper part of the parotid gland; further, you will be led to the large communication from the **auriculo-temporal nerve** which carries secretory fibers to the facial nerve for distribution to the gland. Trace the auriculo-temporal nerve down from the temporal region, behind the capsule of the temporomandibular joint, to the medial side of the neck of the jaw. As far as possible shell the gland free from its fascial bed and trace through it the branches of the facial nerve. Although these are the most superficial structures in the gland, they are very deeply placed, so cut boldly, deeply and radially into the gland substance. As the branches are being followed, remove glandular tissue as necessary. (Occasionally the posterior facial vein is superficial to the branches of the nerve.)

Next, trace the **posterior facial vein** from beginning to end; it lies close against the posterior border of the ramus of the mandible. Lastly, trace the **external carotid artery,** which is deeper and sheltered by the ramus of the mandible. It divides deep to the neck of the mandible into the **superficial temporal** and **internal maxillary arteries.** Hold the chin up, in order to obtain more room.

As though it were the page of a book, raise the entire facial process of the parotid gland off the Masseter and turn it backwards. Cut any branches of the facial nerve that remain. Just as the parotid duct turns round the anterior border of the ramus of the mandible, so the branches of the facial nerve turn round the posterior border, really piercing the deepest part of the gland and leaving but a film of gland

between them and the ramus. Cut the facial nerve about 1″ long, and identify the stylomastoid foramen and the styloid process which descends downwards and forwards. Remove the processes of the gland. To remove the upper process, pass the handle of the knife along the anterior surface of the cartilage of the meatus and scoop this process from the space between the cartilage and the capsule of the temporo-mandibular joint. The other process projects between the styloid process and the internal maxillary vessels which are applied to the medial side of the neck of the jaw. Pull it out in pieces. Now examine the **parotid bed** and the attachments and course of the **Stylohyoid.**

THE TEMPORAL AND MASSETERIC REGIONS

Clean the **temporal fascia.** Review its attachments all round to the margin of the fossa. (These cannot be fully traced since the skull cap has been removed.) Make a vertical cut through the fascia and observe: (1) the temporal muscle fibers arise from its deep aspect (cf. Gluteus Medius), (2) the fascia splits below into two layers which enclose a pad of fat.

Remove the remains of the **masseteric fascia** and clean the **Masseter.** Note the area of bare bone from which the parotid gland has been removed. Detach the posterior third of the Masseter from its origin and turn it forwards in order to display the *masseteric vessels* and *nerve* coming through the mandibular notch a few mms. in front of the capsule of the temporo-mandibular joint.

Pass the closed forceps deep to the zygomatic arch and saw through the zygomatic bone obliquely as far forwards as possible; then saw through the zygoma as far back as possible, and turn down the section of bone with the Masseter attached. In doing this, the vessels and nerve to the

Masseter will be torn. Note the continuity of Temporalis and Masseter fibers at their insertions. The deep layer of the temporal fascia becomes the deep fascia of the Masseter.

Pull the Masseter right down, stripping it from the ramus, but leave it attached below to the margin of the mandible. Define the anterior and the posterior border of the insertion of the **Temporalis.** Remove the pad of fat from between the Temporalis and the lateral wall of the orbit, noting its continuity with the *sucking fat-pad* on the Buccinator. Notice the vertical direction of the pull of the anterior fibers of the Temporalis and the backward sweep of the posterior ones.

THE INFRATEMPORAL REGION

This region lies medial to the ramus of the mandible and cannot be profitably dissected until its bony features have been mastered. Identify, on the medial surface of the ramus of the mandible, the **mandibular foramen,** the **lingula** and the **mylohyoid groove.** With the lower jaw removed identify, on the dried skull, the *anterior wall* of the space; it is the very thin **posterior surface of the maxilla** and it extends from the 2nd and 3rd molar teeth below, to the **inferior orbital fissure** above. The *medial wall* is a muscular process, the **lateral pterygoid plate,** and it meets the anterior wall and supports it. Look above the line of meeting of the two walls and identify a cleft, the **pterygo-palatine fossa.** Later you will realize the importance of this cleft so examine it carefully now. The *roof* of the space is flat and is formed chiefly by the **greater wing of the sphenoid,** but since the **squama of the temporal bone** carries the condyle of the mandible it contributes to the roof a small part in front of the joint. A jagged edge, the **infratemporal crest,** marks the lateral limit of the roof and of the region.

Two foramina are found in the roof: (1) the **foramen ovale**

lies deeply placed near the junction of roof and medial wall. Through it issues the nerve of the region, the **mandibular division** of the **trigeminal** (V^3) which therefore approaches its space from above, behind and medially; (2) the **foramen spinosum,** postero-lateral to (1) and at a noticeable spine (**spine of the sphenoid**) transmits the **middle meningeal artery.**

Replace the mandible in position and now appreciate that the artery of the region, the (internal) **maxillary artery,** approaches its space from behind the neck of the mandible and makes for the pterygo-palatine fossa. A muscle, the **Lateral Pterygoid,** has a similar direction. Therefore the artery runs from superficial to deep *with* the muscle whereas the nerve runs from above downwards and therefore *across* the muscle. An understanding of the essential paths of these three structures will help to make this region, though a little awkward to dissect, at least not difficult to understand.

The dissection of the infratemporal region is to be carried out on the LEFT side only. The right side is to be preserved in order that the tonsillar region may subsequently be dissected.

Detach the coronoid process of the mandible by the following procedure: (a) make a pencil mark at the center of the ramus of the mandible to indicate the site of the **mandibular foramen** (into which the inferior dental vessels and nerve enter); (b) pass a seeker through the mandibular notch and push it obliquely downwards and forwards in contact with the mandible; (c) with the seeker in position as a guard, saw along the line it indicates.

Free and detach from the temporal fossa the anterior and the posterior border of the **Temporalis.** Study the muscle and note the extent of its insertion. Pick out any loose fat in the vicinity of its anterior border, free and trace the *buccal nerve* (a branch of V^3) as it passes backwards through

the insertion of the muscle. Turn the anterior border back and see the *anterior temporal nerve* entering the muscle. Turn the posterior border forwards and see the *posterior temporal nerve* which arises with the nerve to the Masseter. Each nerve is accompanied by a muscular branch of the (internal) maxillary artery. (If the tag-end of the masseteric nerve remains, this will guide you to the posterior nerve to the Temporalis.) Observe these nerves run laterally in contact with the bony roof of the fossa and are a guide to the upper border of the **Lateral Pterygoid.** Removed entirely the Temporalis, leaving, however, buttons of muscle attached to the nerves as identification tags. (Be sure to remove the whole insertion which extends far forwards, almost to the last molar tooth.) Pass a blade of the open forceps behind the neck of the mandible and, keeping it in contact with the bone, run it downwards until arrested by the **lingula,** which should coincide on the medial surface with the pencil-mark on the lateral. With nibbling forceps nibble away the ramus of the mandible above the level of the pencil-mark, leaving only the stout posterior border of the ramus intact. This bar, with the joint, is left intact in order to stabilize the parts. Embalmed bones are brittle, so cover the part with your hand as you nibble, to guard against flying fragments.

Identify the **inferior dental nerve** and **artery.** This large nerve may be obscured at first by periosteum inadvertently left behind when removing bone. If the nerve is traced upwards, it will lead you to the lower border of the **Lateral Pterygoid.** Pick up the equally large **lingual nerve** close in front of, and parallel to, the inferior dental nerve. Trace it upwards similarly to the almost horizontal lower border of the Lateral Pterygoid. Leaving the posterior aspect of the inferior dental nerve is the delicate **nerve to the Mylohyoid** and, joining the posterior aspect of the lingual nerve is the equally

delicate **chorda tympani nerve.** (This, if not within the present field, is a little higher up and will be seen in a moment.)

The inferior dental vessels and nerve are separated from the Medial Pterygoid by a fascial gand, the *spheno-mandibular ligament,* (probably lost in removing the Temporalis) but the lingual nerve rests directly on the muscle, the fibers of which pass nearly at right angles to those of the Lateral Pterygoid. The spheno-mandibular ligament descends from the spine of the sphenoid (situated just medial to the foramen spinosum) to the lingula and the margin of the mandibular foramen. The (internal) **maxillary artery** should be freed where it passes forwards in contact with the medial side of the neck of the mandible—in fact, between the neck and the ligament. Trace the maxillary artery through the region; usually it crosses superficial to the Lateral Pterygoid, but it may pass deep. The artery supplies the muscles of mastication, but the branches requiring particular attention are: (1) inferior dental, (2) middle meningeal, and (3) posterior superior dental. Of these, the **inferior dental artery** has been seen descending on the spheno-mandibular ligament to the mandibular foramen; the **middle meningeal artery** arises opposite it and ascends on the same ligament to the foramen spinosum, and the **posterior superior dental artery,** with its companion nerve, descends on the posterior aspect of the maxilla to the posterior superior dental foramina, but sends twigs beyond these to the gums.

Clean the surface of the **Lateral Pterygoid.** Observe its borders and note its attachments. With the handle of the knife free its upper border from the roof of the fossa, keeping close to the muscle fibers so that the three nerves on the roof —*temporal*, *masseteric* and *auriculo-temporal*—are not dislodged. Taking care of the *buccal nerve* and the (internal) **maxillary artery,** pass the handle of the knife upwards along

the course of the lingual and dental nerves (i.e., deep to the Lateral Pterygoid) and, having freed the muscle, sever it.

A more extensive view of the space is obtained if, at this stage, the head (condyle) of the mandible is removed. Before this is done, however, the temporo-mandibular joint must be examined.

TEMPORO-MANDIBULAR JOINT. Identify the exact position of the loint by manipulating the mandible; then clean the triangular **temporo-mandibular ligament** whose base is attached to the inferior border of the zygomatic process of the temporal bone, and whose short fibres run downwards and backwards to be attached to the posterior border of the neck of the mandible. Saw through the remaining part of the ramus of the mandible below its neck; then enter the point of the knife close below the mandibular (articular) fossa and so open freely the upper cavity of the joint. Remove the **articular disc** with the head of the mandible; with them will be removed also the lateral part of the severed Lateral Pterygoid. Examine the movements the disc enjoys on the head. Cut the disc across antero-posteriorly and so open the lower cavity of the joint. Observe the shape and varying thickness of the disc. Observe also that posteriorly it is attached far down and loosely, and that the Lateral Pterygoid is in part attached to it in front. Read an account of the joint.

Turn again to the examination of the infratemporal fossa. Remove piecemeal, but completely, the remains of the Lateral Pterygoid, scraping clean the lateral surface of the lateral pterygoid lamina. Clean and examine the Medial Pterygoid.

The **mandibular nerve** (V^3) is now exposed. Identify the foramen ovale by passing the point of a seeker through it

from the middle cranial fossa. Follow the **middle meningeal artery** upwards to the foramen spinosum and find, passing backwards applied to the roof, the *auriculo-temporal nerve* whose two roots embrace this artery. By pulling gently on the nerve in front of the ear, prove its identity; then clean and preserve it. The **chorda tympani,** if not seen before, must now be identified; it joins the lingual nerve from behind.

The **Tensor Palati** and the **Levator Palati** lie on a deeper plane than the Medial Pterygoid. They, with the *otic ganglion,* will be examined better when the pharynx is dissected.

PREVERTEBRAL FASCIA AND CERVICAL ANTERIOR RAMI. Raise the upper half of the Sternomastoid and free it up to the mastoid process, preserving the accessory nerve for later study. The head must now be held flexed by the use of blocks. Lift the carotid sheath forwards and pass the fingers behind it, behind the pharynx, and behind the carotid sheath of the opposite side. Observe two definite sheets of fascia: one, the **bucco-pharyngeal fascia,** clothing the posterior aspect of the pharynx; the other, the **prevertebral fascia,** clothing the prevertebral muscles. Demonstrate, by working the fingers between these two sheets, that they extend upwards to the base of the skull, downwards to the superior mediastinum, and laterally behind the carotid sheath. Further, observe that the prevertebral fascia becomes the axillary sheath where it crosses the brachial plexus, and that it is continued as an investing layer around the "lateral" and "posterior" vertebral muscles.

Pick up the **brachial plexus** and follow it medially between the Scalenus Anterior and the Scalenus Medius to the cervical transverse processes. Identify in series the **anterior**

rami of cervical nerves 4, 3 and 2. (C.1 cannot be seen at present.) The muscles between which these emerge are the Longus Capitis anteriorly and the Scalenus Medius and Levator Scapulae posteriorly. Observe the contributions the roots of these nerves make to the already identified nerves (i.e., lesser occipital—C.2, great auricular—C.2 and 3, anterior cutaneous of the neck—C.2 and 3, descending cervical—C.2 and 3, twigs to Levator Scapulae—C.3 and 4, supraclavicular—C.3 and 4, phrenic—C.3, 4 and 5.)

Clean the remains of the carotid sheath from around the upper end of the **internal jugular vein.** Trace the vein upwards to where it lies in front of the transverse process of the atlas. Identify this process by palpation. Trace the **accessory nerve** upwards, and notice whether the internal jugular vein does, or does not, intervene between it and the transverse process. Cut across the internal jugular vein about 1″ above the clavicle; slit the lower part and note the downwardly turned cusps that guard the dilatation known as the **inferior jugular bulb.** Similarly slit the subclavian vein and see a similar device.

The dissection of the **internal carotid artery, internal jugular vein** and the **last four cranial nerves** at the base of the skull is better undertaken after the head has been detached from the vertebral column, but before that can be satisfactorily accomplished the student should read and study an account of the **exterior of the base of the skull** (NORMAL BASALIS) with the dried specimen beside him.

REMOVAL OF THE HEAD

The pharynx, great vessels, last four cranial nerves and the sympathetic trunk are to be separated, with the head, from the vertebral column as follows: Maintaining the head well flexed, pass the knife behind the carotid sheath and esophagus

at the root of the neck and divide all the structures in front of the knife. Turn the subject on to its face and revert for a few moments to the cranial cavity. Remove the spinal cord from the upper $1\frac{1}{2}''$ of the vertebral canal. Feel the **dens** (odontoid process) of the axis. One inch and a quarter below the upper border of the dorsum sellae make a transverse cut $\frac{1}{2}''$ long through the dura mater. From each end of this cut make an obliquely vertical incision downwards to the visible cut-ends of the vertebral arteries. This will run just medial to the jugular tubercle of the occipital bone. With the rounded handle of the knife raise the dura well into the foramen magnum and downwards beyond the dens. This will expose the vertically running fibers of the **membrana tectoria,** attached to the basiocciput well above the foramen magnum. Make a transverse cut through the membrana tectoria above the level of the point of entry of the vertebral arteries (i.e., tip of the dens). Ease the membrane off the back of the dens and so expose the stout, transversely-running fibers of the **check ligaments,** each of which is half as thick as a pencil and very strong. Observe that these ligaments are taut when the head is rotated, flexed or extended. Sever the check ligaments far laterally. Below them you can see immediately the **transverse ligament of the atlas,** with extensions upwards and downwards in the midline known as its *crura.*

Remove the check ligaments from the tip or apex of the dens; cut the upper crus of the transverse ligament, and observe and cut the *ligamentum apicis dentis.* Notice the articular cavity between the dens and the anterior arch of the atlas. Examine the transverse ligament and the bursal space between it and the posterior aspect of the dens.

Return to the neck; sever any remaining nuchal muscles and divide the **posterior atlanto-occipital membrane** by carrying the knife transversely between the arch of the

atlas and the occipital bone. [N. B. If you keep the head well flexed while carrying out this procedure, there will be less danger of the knife passing between atlas and axis instead of between atlas and occipital.]

Turn the subject on to the back. Hold the pharynx, vessels and nerves forwards and *now include the sympathetic trunk*. Pass the knife between the transverse process of the atlas and the jugular process of the occipital bone, and sever the **Rectus Capitis Lateralis** on each side. Carry the knife across the midline above the anterior arch of the atlas and sever the **anterior atlanto-occipital membrane.** Sever the **Rectus Capitis Anterior** and the **Longus Capitis.** Now, on twisting the head first to one side and then to the other, the interval between the occipital condyle and the atlas (atlanto-occipital joint) may be felt, the capsular ligaments torn or cut, and the head detached. Wrap up and put aside the detached head.

PREVERTEBRAL AND LATERAL VERTEBRAL MUSCLES. Find the loop joining C.2 to C.1 across the front of the root of the transverse process of the atlas. This loop is between the Rectus Capitis Anterior, which is medial, and the Rectus Capitis Lateralis, which is lateral. Study the muscles now exposed.

Before dissecting the vertebral artery, you have a good opportunity now to review (a) the boundaries of the "triangle of the vertebral artery" and its posterior wall, and (b) the gangliated sympathetic trunk.

Examine the attachments of the **Scalenus Anterior, Longus Capitis** and **Longus Cervicis,** then remove these muscles from the anterior tubercles of the transverse processes. See and then remove the *Anterior Intertransverse muscles.* Trace a root of either the cervical or the brachial plexus to an inter-

vertebral foramen. Snip away the anterior roots of the transverse processes to lay bare the **vertebral artery.** The roots of the two plexuses—cervical and brachial—must be traced behind the artery to the intervertebral foramina from which they issue. Between the transverse process of the axis and that of the atlas, observe that the vertebral artery swings laterally in this extensive interval. Pick up the cut ends of the **suboccipital** and **greater occipital nerves** and explore their courses. Particularly notice their relations to the vertebral artery and to the joints. Pick up one of the lower roots of the brachial plexus (i.e., an **anterior nerve ramus**) and notice that, when traced backwards, it joins a much smaller **posterior nerve ramus;** still more medially observe a **posterior root ganglion.** The posterior ramus swings backwards round the bony column formed by the articular processes, and in so doing crosses an obliquely placed joint. Remove the capsule from the joint between the articular processes of the atlas and axis, and observe the inwardly projecting synovial fringe.

THE VESSELS AND NERVES AT THE JUGULAR FORAMEN. A knowledge of the ultimate destination of each of the last four cranial nerves will make their dispositions at the base of the skull easier to appreciate. Consider these facts:

1. The **sigmoid sinus** approaches the jugular foramen from the lateral side; the four nerves approach it (or the hypoglossal canal) from the medial side having come from the brain stem.
2. Nerve IX (**glossopharyngeal**) is destined for the pharynx and back of the tongue; it must swing medially at once.
3. Nerve X (**vagus**) belongs to the digestive tract; it must proceed straight downwards.
4. Nerve XI (**accessory**) is destined for the Sternomastoid

and Trapezius; it must pass laterally and therefore across the path of the internal jugular vein.

5. Nerve XII (**hypoglossal**) is destined for the muscles of the tongue; it must swing medially but takes a wider sweep than N. IX since it passes well forwards. It swings round both carotid arteries.

Pick up the cut end of the **common carotid artery.** Trace the **sympathetic trunk** (which lies behind the common and internal carotids) up to the carotid canal. Observe its long fusiform ganglion, the **superior cervical ganglion,** reaching as low as the angle of the jaw. Preserve any branches from it.

The line that joins the anterior margins of the two mastoid processes may be called the *"posterior transverse line"*. Notice the relation of this line to the **styloid** and **mastoid processes,** to the **jugular foramen, hypoglossal canal, occipital condyles** and **foramen magnum.** Then identify on this line the **stylo-mastoid foramen** and the issuing **facial nerve.** Identify, issuing from the jugular foramen, the **internal jugular vein** and **nerves IX, X** and **XI.** Separated from the foramen by a bar of bone is the **hypoglossal canal** from which emerges nerve **XII.**

Anterior to these nerves is the **sympathetic trunk** which, with the nerves, conceals the more anteriorly placed **internal carotid artery** entering the **carotid canal.** The posterior wall of the **pharynx** hangs from the basi-occiput well in front of the foramen magnum and has the great vessels and nerves postero-lateral to it. Here the pharynx is widest (2″) and reaches, on each side, almost as far laterally as the inferior opening of the carotid canal.

Trace the **internal jugular vein** up to its foramen. Between this vein and the internal carotid artery pick up the **vagus**

nerve (X) and trace it also to the skull. Observe an inch long swelling on its course, the **inferior ganglion of the vagus.** Arising from the vagus nerve about an inch below the base of the skull is the **superior laryngeal nerve**; identify it and observe that, as it descends, it passes medially, behind both carotids. Just above it is the **pharyngeal branch** passing medially, between the two carotids.

At the base of the skull the **hypoglossal nerve** (XII) will be found describing a half-spiral behind the inferior ganglion of the vagus nerve and adhering closely to it. The hypoglossal nerve descends to the level of the angle of the jaw where it curves forwards superficial to both carotid arteries. The **accessory nerve** (XI) still has a button of Sternomastoid attached to it; pick it up and trace it to the base of the skull where it is immediately lateral to the vagus nerve. Find the **cranial root** (bulbar portion) of the accessory nerve joining the vagus beyond its ganglion.

Identify the styloid process once more in the parotid region. Note the **facial nerve** (VII) curving forwards lateral to it and the tendon of the **Stylohyoid** arising laterally near the base of the process. Reverting to the posterior aspect of the specimen, pull the posterior belly of the **Digastric** laterally and re-identify the styloid process, facial nerve and Stylohyoid. The **internal jugular vein** grooves the medial side of the root of the styloid process. Displace the vein laterally and see the fleshy **Stylopharyngeus** arising from the length of the medial aspect of the process. (A glimpse of the **Styloglossus** arising from the tip may be obtained.) Pick up the **glosso-pharyngeal nerve** (IX) turning spirally downwards and forwards closely applied to the lateral side of the Stylopharyngeus. Trace it upwards to the base of the skull where it lies in front of nerves X and XI, and downwards almost as far as nerve XII.

THE PHARYNX FROM WITHOUT

The wall of the pharynx consists of four coats: **areolar, muscular, fibrous, mucous.** The areolar coat is continuous with that of the Buccinator and is therefore called the **bucco-pharyngeal fascia.** Besides allowing for movements of the pharnyx on the prevertebral fascia it contains the pharyngeal plexus of veins and of nerves. Read an account of these plexuses. The muscular coat is in two layers; (1) an **outer circular coat,** the three **Constrictors of the pharynx,** and (2) an **inner longitudinal coat,** seen to better advantage from within. The fibrous coat is the 'framework' of the pharynx and is known as the **pharyngo-basilar fascia** (aponeurosis) which together with its mucous lining is also better investigated from within.

Begin the dissection of the Constrictors by cutting the external carotid arteries between the points of origin of thė superior thyroid and lingual arteries and thus gain more room. Be sure that your knife is sharp, that the parts are moist and that the light is good. Study the **Buccinator** and clean its origin from the pterygo-mandibular ligament (raphe) already identified, and from the upper and lower jaws. At this ligamentous attachment the Buccinator blends with the Superior Constrictor. Clean the **Superior Constrictor** by removing the bucco-pharyngeal fascia from its surface and follow the course of its fibres. Your objective is to display three features: (1) the upper free edge on each side of the pharyngeal tubercle. The details of the space found above this free edge will be studied later; (2) the Middle Constrictor overlapping the lower part of the Superior; (3) the lower free edge where, between the Superior and the Middle Constrictor, the **Stylo-pharyngeus muscle** and the **glosso-pharyngeal nerve** enter the pharynx.

Clean the **Middle** and **Inferior Constrictors** in similar

fashion and display: (1) the upper and lower free edges; (2) the overlapping of the Middle by the Inferior Constrictor; (3) the **internal laryngeal nerve** and **superior laryngeal vessels** piercing the thyro-hyoid membrane between the two muscles; (4) the continuity of the Inferior Constrictor at its origin from the thyroid cartilage with the **Crico-thyroid;** (5) the **recurrent (laryngeal) nerve** and **inferior laryngeal artery** entering the pharyngeal wall below the horizontal free border of the Inferior Constrictor. Read an account of the three Constrictors, and of the pharyngo-basilar fascia.

THE PHARYNX FROM WITHIN

Slit the posterior pharyngeal wall in the midline right up to the base of the skull and view the pharynx from within. Opening into it anteriorly are orifices leading from the cavities of the nose, mouth and larynx. Accordingly it is divided into 3 parts; the **naso-pharynx, oral pharynx,** and **laryngeal pharynx.** The soft palate, ending in the uvula, hangs down and separates the naso-pharynx above, from the oral pharynx and laryngeal pharynx below.

The **naso-pharynx** lies above the soft palate, and behind the nasal cavities. It is, in fact, the backward extension of the nasal cavities and it cannot be shut off from them. In front, are two oblong rigid bony orifices, the **posterior apertures (choanae)** of the nose. Refer to the dry skull and check your text-book account of the bony boundaries of the **posterior choanae.** On looking through these apertures the posterior ends of the **middle** and **inferior conchae** are seen. On the side wall of the pharynx half-an-inch behind the inferior concha is the orifice of the **pharyngo-tympanic tube** (the auditory tube of Eustachius). Its upper and posterior lips are prominent and cartilaginous. A fold of mucous membrane, the **salpingo-pharyngeal fold,** overlying a muscle,

the **Salpingo-pharyngeus,** descends from its postero-inferior part and gives it the appearance of a hook. Behind the orifice there is a vertical cleft, the **pharyngeal recess,** which extends under the petrous bone almost to the carotid canal, so here the pharynx is two inches wide. The roof, formed by basi-occipital and petrous bones, is rounded off into the posterior wall which lies in front of the atlas and axis but with prevertebral muscles intervening. On the roof there is some lymphoid tissue, the **naso-pharyngeal tonsil,** which when overgrown is known as "adenoids." This tissue extends into the pharyngeal recess behind the pharyngo-tympanic tube.

The **oral pharynx** is placed below the soft palate and behind the mouth and tongue. From the soft palate two folds of mucous membrane arch downwards on each side. The anterior fold, the **palato-glossal arch,** overlies a muscle, the **Palato-glossus,** and descends to the junction of the anterior 2/3 and posterior 1/3 of the tongue. It lies at the dividing line between mouth and pharynx. The posterior fold, the **palato-pharyngeal arch,** also overlying a muscle, the **Palato-pharyngeus,** arches downwards to be lost on the side wall of the pharynx. On each side, between the two palatine arches lies the **tonsil** (palatine tonsil).

The **laryngeal pharynx** lies behind and around the freely projecting upper end of the larynx. The inlet of the larynx is oval and obliquely placed. In front, it is formed by the free, curved, upper end of the **epiglottis;** behind, by the mucous membrane clothing the apices of the **arytenoid cartilages** and the **Arytenoideus,** which unites these cartilages; on each side, by the **ary-epiglottic fold** which extends from epiglottis to arytenoid. Slightly in front of the apex of the arytenoid cartilage, which is surmounted by the *corniculate cartilage,* is the rounded end of the *cuneiform cartilage.* Three folds of mucous membrane leave the epiglottis; one, the **glosso-**

epiglottic fold, connects it in the median plane with the back of the tongue; one on each side, the **pharyngo-epiglottic fold,** connects it with the pharyngeal wall. Between these three folds are two finger-tip depressions, the **valleculae.** Behind the pharyngo-epiglottic fold on each side there is a space, the **piriform fossa,** which is bounded by the thyroid cartilage and thyrohyoid membrane laterally and by the wall of the larynx medially. On the posterior wall of the pharynx numerous lymphoid follicles are scattered. They may become enlarged.

Exposure of the internal and recurrent laryngeal nerves. These two nerves, being submucous, are readily exposed. The internal laryngeal nerve runs transversely in a fold across the front of the piriform fossa; it is a sensory nerve. The recurrent laryngeal nerve runs perpendicularly applied to the back of the crico-thyroid joint. It is a mixed nerve which supplies all the muscles of the larynx except the Crico-thyroid. Incise the mucous membrane along the line indicated and expose the internal laryngeal nerve. Trace it in continuity to its source. Verify the position of the recurrent laryngeal nerve relative to the crico-thyroid joint.

THE BISECTED HEAD

In bisecting the head begin by cutting through the upper lip in the midline. Next explore each nasal cavity with a probe in order to determine which is the more open. (The septum usually deviates somewhat to one side). Slit the anterior nares on the more open side; slit also the uvula and the soft palate in the midline. Insert the blade of a small saw into the chosen side of the nasal cavity, with the teeth of the saw facing forwards and, keeping the blade close to the septum, push the point of the saw through the cribriform plate of the ethmoid, and cut forwards through the frontal

and nasal bones. Now place the small saw in the cut from above, and saw backwards through the rest of the cribriform plate and through the body of the sphenoid. When the cutting begins to get harder replace the small saw with a large one and cut through the posterior part of the skull, in the midline, until the foramen magnum is reached. Next divide the basi-occiput and dorsum sellae, joining up with the cuts made with the small saw.

Turn the specimen upside down. The Mylohyoid is visible between the anterior bellies of the Digastrics. Divide it in the midline and identify, deep to (above) it, the paired Genio-hyoidei passing, one on each side of the midline, from the mandible near its symphysis to the body of the hyoid bone. Separate the Geniohyoidei from one another without injuring either, and clean the sites of their pointed origins on the mandible. Saw through the mandible between these two cleaned origins, being careful not to injure the tongue. The two halves of the head will now fall apart from each other. Turn the specimen over and examine the tongue.

THE TONGUE.

By inspection verify the following statements:

1. The anterior two thirds of the tongue, the **oral part,** is horizontal and lies in the mouth; the posterior one third, the **pharyngeal part,** is vertical and lies in the pharynx.
2. The boundary between the two parts is marked on the dorsum of the tongue by a V-shaped line, the **sulcus terminalis,** which runs backwards on each side from the neighbourhood of the palato-glossal arch to a median pit, the **foramen cecum linguae.**
3. The **glosso-epiglottic fold** of mucous membrane runs from the dorsum of the tongue to the epiglottis and separates the **valleculae.**

4. The dorsum of the anterior two-thirds of the tongue is covered with V-shaped rows of pointed **filiform papillae** among which the globular heads of **fungiform papillae** lie scattered, chiefly near the tip and at the margins.
5. **Foliate papillae,** rudimentary in man, are 3–4 vertical folds at the hind part of the side of the tongue.
6. Large and conspicuous **vallate papillae,** 12 or so in number, occupy a V-shaped row just in front of the sulcus terminalis.
7. The surface of the pharyngeal part of the tongue is conspicuously different from the oral part. It is smooth and covered with encapsuled lymphoid nodules which collectively constitute the **lingual tonsil,** indefinitely separated from the palatine tonsil.

Continue now the process of bisecting the specimen. Now that the mandible is divided, the interval between the paired Geniohyoidei is wider. Turn the specimen over and identify the paired Genioglossi lying immediately deep to (above) the Geniohyoidei. Open the areolar interval between the two Genioglossi and observe that, as the dissection is carried deeper, the substance of the tongue is entered along its midline areolar septum. Open this septum as deeply as possible, then push the knife, with the blade facing forwards, through the thickness of the tongue on to its dorsum and cut the tongue forwards to its tip. Withdraw the knife, turn the specimen over and work from the dorsum of the tongue. Be careful now to avoid injury to the epiglottis as you cut the remainder of the horizontal part of the tongue backwards to the midline glosso-epiglottic fold. Still watching the epiglottis, cut the vertical part of the tongue down to the hyoid bone in the midline.

Lastly, taking care of the hypoglossal nerve and lingual artery, carry the knife TO THE LEFT along the upper surface of the body and greater cornu of the hyoid bone, thus severing

the Hyoglossus and the Middle Constrictor. If this dissection is properly carried out your specimen will be in two separate parts, of which the right part will carry the undissected infra-temporal region and the larynx. This procedure allows two dissectors to be at work simultaneously.

THE NASAL CAVITIES

These are bilateral passages at the beginning of the respiratory tract. They serve to filter and warm the inspired air; for these purposes they are equipped with delicate scroll-like shelves set on their lateral walls, and with a lining **muco-periosteum** possessing very large and numerous venous channels.

Excavations hollowing out the surrounding bones produce a series of **air sinuses,** all of which communicate with the nasal cavities and are similarly lined with muco-periosteum continuous with that of the nose. These sinuses, besides lightening the bones of the face, give resonance to the voice and are to be investigated with the nasal cavities. The dissector should examine in turn, the anterior aperture, posterior aperture (choana), floor, roof, medial wall (septum) and lateral wall. It is the last of these that is complicated by the presence of the afore-mentioned scrolls (**conchae** or turbinates) and by the existence of communications with the sinuses.

Anterior aperture: Review its boundaries already dissected and verify that it is kept patent by the U-shaped lower nasal cartilage.

Posterior aperture: Review its bony boundaries.

Floor: Notice that it is smooth, concave from side to side, horizontal and narrow, and that it is formed by the upper surface of the hard palate.

Roof: This consists of three parts. Identify on the dried skull and on the cadaver the structures entering into the formation of each part.

1. Anterior sloping part, formed by upper nasal cartilage, nasal bone and spine of the frontal bone.
2. Intermediate horizontal part, formed by the cribriform plate of the ethmoid.
3. Posterior part, formed by the anterior and inferior surfaces of the body of the sphenoid.

Medial wall or **septum** (usually deflected somewhat to one side): Strip the muco-periosteum completely off one side and identify the three main components of the septum: (1) the **perpendicular plate** of the **ethmoid** above; (2) the **vomer** below and behind; (3) the **septal cartilage** in front. Observe the slight contributions made to the periphery of the septum by crests on the palatine, maxillary, nasal, frontal and sphenoidal bones. The mobile part of the septum at the anterior aperture probably has been noted already.

Proceed now to remove the bony and cartilaginous parts of the septum on this same side, leaving the mobile part and the muco-periosteum of the far side intact so that the arteries can be seen and the nerves perhaps dissected.

If the arteries are not injected they are difficult to follow. Descending from above are branches of the **anterior** and **posterior ethmoidal arteries.** Running downwards and forwards in a groove on the vomer is the **long spheno-palatine artery.** A twig from the **greater palatine artery,** already seen and dissected on the under surface of the palate, ascends through the incisive canal, whilst a twig from the **superior labial artery** supplies the mobile septum. Do not delay long over any of these.

The nerves of the septum are:

(1) **olfactory branches,** occupying a small area above and behind.

(2) branches of the **anterior ethmoid nerve,** better seen when the lateral wall is dissected. These two sets of branches descend from above.

(3) **long spheno-palatine nerve,** accompanying the artery of the same name. It should be readily found and traced to where it passes through the incisive canal.

(4) twigs of the **infra-orbital nerve,** supplying the mobile part of the septum.

Remove all remains of the septum by cutting it round its periphery and so expose the lateral wall.

Lateral wall: Inspect the lateral wall and identify:

1. **Inferior concha** and the space below it, the **inferior meatus.**
2. **Middle concha** and the space below it, the **middle meatus.** Notice that these two conchae fail to reach the posterior aperture by the width of the medial pterygoid plate. Half-an-inch behind the posterior limit of the inferior concha is the opening of the pharyngo-tympanic tube. The free edge of the inferior concha is horizontal, that of the middle concha, however, turns obliquely upwards in front.
3. **Superior concha,** small and rudimentary in man, extending from the middle of the roof to the middle of the front of the sphenoidal body. Below it lies the **superior meatus.**
4. **Spheno-ethmoidal recess,** the space above and behind the superior concha.
5. **Meatus communis,** the narrow cleft extending from roof to floor between the conchae and the septum.

6. **Vestibule,** in front of the inferior meatus, and guarded by hairs, the **vibrissae.**
7. **Atrium,** in front of the middle meatus and above the vestibule.

Anterior to the atrium the lateral wall is formed by the nasal bone and the upper nasal cartilage. Remove the muco-periosteum covering them in order to see the **external nasal nerve and vessels** descending in a groove on the nasal bone.

With scissors cut away the inferior concha and note its curved line of attachment. Pass a blunt probe from the orbital cavity down the **naso-lacrimal duct** into the inferior meatus noting that its direction is downwards and backwards and that it traverses the mucous membrane obliquely. Notice where the flap valve thus formed opens. Remove the muco-periosteum from the inferior meatus and note the bony **naso-lacrimal canal** opens at the summit of attachment of the inferior concha. Observe that the thinnest part of the lateral wall of the inferior meatus is just behind this opening. Break through this thin area into the **maxillary air sinus.**

With the scissors cut away the middle concha. Pass a curved probe from the lowest part of the **frontal sinus.** It enters the middle meatus at the anterior end of a curved groove, the **hiatus semilunaris.** This hiatus has a sharp lower edge; above it notice a swelling, the **bulla ethmoidalis.** The cell in the bulla and two or three others above the hiatus are the **middle ethmoidal cells.** Notice at the anterior end of the hiatus the **ostium of the maxillary sinus.** Observe that this ostium is at the highest part of the sinus. Look for an **accessory ostium,** and, in front of the hiatus semilunaris, see the orifices of one or more **anterior ethmoidal cells.** With the blunt probe still in place in the naso-lacrimal duct, break through the papery lacrimal bone from the middle meatus into the duct as the surgeon may in order to secure drainage

when the duct is obstructed. In front of the thin lacrimal bone here is the stout **fronto-nasal process of the maxilla.**

Remove the superior concha in order to see one or more **posterior ethmoidal cells.** Pick away, one by one, the partitions between the ethmoidal cells in order to display the thin **orbital plate** (lamina papyracea) of **the ethmoid which** closes the cells laterally and at the same time forms the medial wall of the orbital cavity.

Explore the extent of the **sphenoidal sinus,** the two are rarely symmetrical and either or both may extend into the basi-sphenoid and even into the basi-occiput. Observe the orifice of the sinus high up and opening into the spheno-ethmoidal recess. Pass wires along the optic canal, foramen rotundum and pterygoid canal and note that these are commonly in contact with the side and lower wall of the sinus. Observe the relation of the sinus to the hypophysis cerebri above and to the cavernous sinus and internal carotid artery laterally.

With the aid of bone forceps remove the greater part of the medial wall of the maxillary sinus. Notice that it is a four sided hollow pyramid, whose base is its nasal wall; its apex stretches towards or even into the zygomatic bone; its translucent sides are facial, infratemporal and orbital. Observe: (1) the ridge on its orbital and facial walls created by the infra-orbital canal; (2) the floor lying below the level of the floor of the nose and shewing septa projecting upwards in the vicinity of the roots of the molar teeth; (3) the high position of its ostium. Remove the muco-periosteum lining the sinus and so expose **anterior** and **posterior dental vessels** and **nerves,** occupying bony canals or gutters.

Read an account of the nasal cavities and paranasal sinuses and their blood and nerve supplies.

EXPLORATION OF THE SPHENO-PALATINE FORAMEN. Push the end of a seeker through the mucous membrane and lateral wall of the nasal cavity at a point just above the line of attachment of the middle concha and a quarter of an inch in front of its posterior end. This point is flush with the under surface of the body of the sphenoid bone. The hole entered is called the **spheno-palatine foramen** because the sphenoid bounds it above and the palatine bone bounds it in front, below and behind. The chief vessels and nerves of the nasal cavities pass through this foramen, so, in a sense it is the "porta" or door of the nasal cavities.

Substitute a thin straight probe or needle for the seeker and force it horizontally through the foramen; and, for purposes of orientation, observe that it traverses the pterygo-palatine and infratemporal fossae and strikes the zygomatic arch far forwards.

Piercing the bony palate medial to the third molar tooth is the **greater palatine foramen.** It lies almost vertically below the spheno-palatine foramen. The greater palatine vessels and nerve emerge from the greater palatine foramen and run forwards in two grooves, separated by a sharp crest, on the under surface of the bony palate near the alveolar margin. To find the foramen a seeker should be made to penetrate the mucous membrane of the palate abreast of the 2nd molar tooth and should be pushed upward and backwards until its tip slips over the rounded anterior margin of the foramen.

There is, of course, no muscle under the hard palate; it could there have no action. The brown tissue seen there is a carpet of racemose mucous glands, which becomes much thicker under the soft palate. The periosteum adheres more intimately to the mucous membrane than to the bone, hence the two are referred to as **muco-periosteum.** With the aid

of the handle and point of the knife ease the muco-periosteum off the palate. First make a transverse cut through the thickness of the tissues of the palate, beginning just behind the point at which the seeker was inserted into the greater palatine foramen and ending at the sawn edge in the middle line. Be sure to keep the cut $\frac{1}{4}''$ in front of the posterior sharp border of the hard palate, thereby avoiding injury to the **palatine aponeurosis** which is attached to, and is continuous with, this sharp border. Now, with the rounded handle of the knife ease an anterior flap of muco-periosteum off the hard palate as far laterally as the alveolar margin, and free the vessels and nerve issuing from the greater palatine foramen and passing forwards.

Piercing the bony palate behind the incisor teeth is the **incisive canal.** A process of the nasal septum (the vomer) descends into the incisive canal dividing it into right and left sides. Through each side a branch of the greater palatine artery ascends to anastomose on the nasal septum with the **long spheno-palatine** (naso-palatine) **artery,** and the **long spheno-palatine nerves** descend through the hinder part of the canal to the under surface of the premaxilla.

Incise the muco-periosteum of the nose along the line joining the spheno-palatine and the greater palatine foramina. [The fleshy tips of the middle and inferior conchae (now removed) extended backwards on to the **vertical plate of the palatine** bone and crossed this line.] The knife will be arrested below by the horizontal part of the palatine bone. Then, with the handle of the knife, strip back the muco-periosteum for the requisite third of an inch in order that the entire medial aspect of the **medial pterygoid lamina** may be exposed and its posterior border, which gives attachment to the pharyngo-basilar fascia, defined.

Pass a long needle into the greater palatine foramen and

upwards through the greater palatine canal and pterygo-palatine fossa to the level of the spheno-palatine foramen and leave it in place. Then, with a strong probe proceed to break down the delicate intervening portion of the lateral wall of the nose formed by the vertical plate of the palatine bone. This exposes the greater palatine nerve and artery. The nerve is to be followed to the **spheno-palatine ganglion** on the **maxillary nerve;** the artery is a terminal branch of the maxillary artery.

Between the greater palatine foramen and the hamulus is the tubercle (pyramidal process) of the palatine bone. It is pierced by two small foramina, the *lesser palatine foramina,* which transmit the *lesser palatine vessels and nerves* to the neighbourhood of the soft palate and tonsil. These should be sought.

THE PTERYGO-PALATINE FOSSA has been located already. Identify it now on the dried skull and observe the pathways open to the nerves and vessels that lie within it:

1. *Medialwards*, to the **nasal cavity** via the **spheno-palatine foramen,** whence vessels and nerves may cross the roof to gain the septum or may at once ramify on the lateral nasal wall.
2. *Downwards*, to the **palate** via the **greater and lesser palatine canals** whence, by piercing the wall of the canal, vessels and nerves may gain the lateral nasal wall, or by issuing from the greater and lesser palatine foramina may gain the under surface of the palate.
3. *Backwards*, to the **middle cranial fossa** via: (a) the **foramen rotundum;** (b) the **pterygoid canal.** Find these two openings in the middle cranial fossa and pass bristles through them. The foramen rotundum offers no trouble. The pterygoid canal is located immediately

supero-lateral to the pterygoid tubercle which itself lies at the anterior border of the lower end of the foramen lacerum. A minute groove or canal on the under surface of the vaginal process of the medial ptergoid plate also passes backwards to the roof of the naso-pharynx.

4. *Forwards*, to the floor of the **orbit** via the hind part of the **inferior orbital fissure;** thence, via the infraorbital groove, canal and foramen to the face.
5. *Lateralwards*, to the **infratemporal region** via the **pterygo-maxillary fissure.**

Turn to the specimen on which the infra-temporal region is dissected and find within the fossa: (1) the **maxillary nerve,** as it swings across from the foramen rotundum behind, to the inferior orbital fissure in front; (2) the **spheno-palatine ganglion,** already identified and suspended from the maxillary nerve by two short stout nerves; and (3) the third part of the (internal) **maxillary artery** entering the fossa from the infratemporal region.

Read an account of these three structures and their distributions and do not leave the region until you understand the significance of the spheno-palatine ganglion as a parasympathetic cell station on the secretory pathway of the greater superficial petrosal nerve.

PALATE, TONSIL, PHARYNGEAL WALL

THE UNDER SURFACE OF THE PALATE. The anterior two-thirds of the palate has a bony framework and is called the **hard palate;** the posterior one third has a fibrous framework, the **palatine aponeurosis,** and is called the **soft palate.** Pinpoint orifices of the ducts of mucous glands are dotted over the hard palate and are abundant over the soft palate. Look for them and observe several rudimentary ridges present in the anterior part of the hard palate.

The muco-periosteum has been stripped already from most of the hard palate. In dealing with the soft palate begin at the lateral end of the transverse cut previously made and ease the muco-periosteum off the remaining quarter of the hard palate. As the soft palate is approached you will be conducted to a plane beneath the palatine aponeurosis. This aponeurosis is continuous with the sharp posterior border of the bony palate and should not be injured as you proceed to turn down a posterior flap of the soft palate. On encountering muscle, present only in the posterior two thirds of the soft palate, you will require the assistance of the point of the knife. Verify the statements that the thickness of the soft palate is due to glands and to a smaller extent to muscles; that its strength depends on its aponeurosis situated in its anterior one third; and that its mobility is due to muscles situated in its posterior two-thirds. These muscles will be investigated in more detail in conjunction with the inner muscular coat of the pharyngeal wall.

THE PALATINE TONSIL. The tonsil lies in the side wall of the pharynx in the triangular interval between the **palato-glossal** and **palato-pharyngeal arches** and the posterior third of the tongue. An upper and a lower fold of mucous membrane (*plica semilunaris* and *plica triangularis*) may extend from the palato-glossal arch backwards over its anterior part, forming an upper and a lower pocket.

Proceed to remove the tonsil by incising the mucous membrane along the palato-glossal arch, and with the point and handle of the knife free the upper part of the anterior border of the tonsil. This is easily done because the rounded lateral aspect of the gland has a fibrous capsule, which is separated from the pharyngeal wall by a layer of loose areolar tissue in which free dissection is readily made.

If, as a result of tonsillitis, the areolar space is in part obliterated and dissection difficult, prefer damaging the tonsil to damaging the pharyngeal wall. After setting free the anterior part of the tonsil, shell out the upper pole which extends upwards into the soft palate beyond the arches, and is there buried. Then free the posterior border. Working always in the areolar space, detach the rest of the gland (i.e., lower pole and lower part of anterior border where the gland is most adherent) and note that the lower pole is continuous with the lymphoid tissue on the back of the tongue, called the **lingual tonsil.** The upper pole, then, is buried; the lower pole is not visible unless the tongue is depressed; and a very prominent anterior pillar may largely conceal even an enlarged tonsil.

The lower part of the tonsil is moored to the tongue by a fibrous band and by some muscle fibres which help to prevent it from being swallowed. These and the vessels and nerves which enter near the lower pole must be severed and the tonsil removed.

When the tonsil has been enucleated, make a section through it and observe the white test tube-like **crypts** that extend from its free surface almost to the very capsule.

The tonsil bed. Lateral to the loose areolar tissue surrounding the fibrous capsule of the tonsil there are three thin sheets —one fibrous and two fleshy—which constitute the tonsil bed. From within outwards they are (1) the **pharyngo-basilar fascia** (now lying exposed) which forms a complete filmy sheet, (2) the **Palato-pharyngeus** and (3) **Superior Constrictor** both of which are deficient below. A large vein, the **paratonsillar vein,** descending from the soft palate and receiving tributaries from the tonsil, pierces the lower part of the tonsil bed to join the **pharyngeal plexus;** it is not likely to be seen unless engorged.

Two structures passing to the tongue, (1) the **Styloglossus** and (2) the **glossopharyngeal nerve,** form immediate lateral relations of the lower third of the tonsil bed. They are to be exposed and cleaned by removing the thin fascial sheath which alone covers them here, the muscle sheets having faded off into delicate arched borders. The Styloglossus is a broad thick band commonly standing out in relief as it passes downwards medially and forwards to the horizontal part of the tongue (i.e., the anterior $\frac{2}{3}$). The glossopharyngeal nerve is larger than the internal laryngeal nerve and is placed far back; on appearing from under cover of the lower arched borders of the muscle sheets, it passes downwards, medially and forwards to spread out submucously over the vertical part of the tongue (i.e., the posterior $\frac{1}{3}$). Look for it immediately lateral to the palato-pharyngeal arch, two-thirds of the way down the tonsil bed.

The posterior belly of the Digastric and the submandibular gland with the facial artery arching over them are lateral relations of the lowest part of the bed, and further laterally are the Medial Pterygoid and the angle of the jaw—but these will be seen later.

Read an account of the vessels and nerves of the tonsil.

Pharyngeal Wall. Identify the **hyoid bone** from within the pharynx, then pull backwards the epiglottis and, on the right side, incise the mucous membrane along the body and greater horn of the hyoid down to the bone. The incision will pass between the epiglottis and the tongue, across the valleculae and the glosso-epiglottic and pharyngo-epiglottic folds. To get free exposure carry the incision along the greater horn to its tip and beyond this to the median plane; then strip the mucous membrane from the pharyngeal wall upwards over an area extending from the level of the back of

the tongue below, to the level of the soft palate above. Find the lesser horn, which till after middle life is cartilaginous, and carry the point of the knife upwards and backwards along the anterior free edge of the stylo-hyoid ligament towards the styloid process of the temporal bone, but stop at the curved lower border of the Palato-pharyngeus. Since the Middle Constrictor takes origin in the angle between the two horns of the hyoid and the lower end of the stylo-hyoid ligament, it also is submucous at its origin. Being fan-shaped, its borders curve up and down; and along its upper border runs the IX nerve. A few deep fibers of the Hyoglossus pass from the cartilaginous lesser horn to the tongue—hence called the *Chondroglossus*—and when removed, the **lingual artery** and the **Hyoglossus** are in view. The **Hyoglossus** arises from the whole length of the greater horn. It is crossed on its medial surface by the lingual artery and on its lateral surface by the hypoglossal nerve. Though the nerve should not be disturbed just now, its thick trunk should be identified at the posterior border of the Hyoglossus where it is superficial to the lingual artery.

The Palato-Glossus and Palato-Pharyngeus. On freeing the mucous membrane from the palato-glossal arch the **Palato-glossus** is displayed as a small bundle of fibres that extends from the soft palate above, where its fibres mingle with those of the opposite side, to the tongue below, where the fibres enter as transverse fibres. A more or less circular sphincter is thus formed which guards the orifice to the oral pharynx. Strip the mucous membrane from the upper surface of the soft palate and from the whole naso-pharynx up to the level of the pharyngo-tympanic tube, thereby exposing the **Palato-pharyngeus.** It is a representative of the longitudinal musculature of the pharynx.

Traced upwards the Palato-pharyngeus is found to separate

into three distinct parts—*tubal*, *palatal* and *tonsillar*. Its tubal fibres, the **Salpingo-pharyngeus,** form a slender bundle that ascends in the salpingo-pharyngeal fold to the lower edge of the cartilage of the pharyngo-tympanic (auditory) tube. Its palatal fibres spread out in the posterior two thirds of the soft palate. Its tonsillar fibres spread out within the tonsil bed. Traced downwards the Palato-pharyngeus spreads out so as to form an almost complete inner sheet of muscle in the lower parts of the pharynx; some fibres pass to the posterior border of the thyroid cartilage and some to the hyoid. The posterior edge of this muscle is easily identified because its fibres run nearly vertically whereas those of the Constrictor lie outside it and take a more horizontal course. Define and raise the posterior part of the Palato-pharyngeus; divide it transversely at the level of the hyoid bone and dissect its severed ends up and down. A little care is needed to avoid injuring the rounded Stylo-pharyngeus, which passes through the hinder part of the gap between S. and M. Constrictors and blends with the Palato-pharyngeus. Detach the tubal fibres from the pharyngo-tympanic tube; trace the palatal ones into the palate; and if feasible, separate the tonsillar sheet of fibres from the underlying S. Constrictor and trace it forwards to the thread-like pterygo-mandibular ligament from which it takes origin. Having freed the muscle, discard it.

The origin of the Superior Constrictor is now unveiled. It is practically co-extensive with the tonsillar part of the Palato-pharyngeus. It arises from the pterygo-mandibular ligament, which unites it to the Buccinator, and from the bony parts at both ends of the ligament, namely the hamulus of the pterygoid plate above, and the mandible behind the third molar tooth below; and fibres join the tongue.

All remaining mucous membrane is now to be removed from the naso-pharynx. The Superior Constrictor has been seen to possess an upper free border. The gap between it and the base of the skull is filled by the pharyngo-basilar fascia, the fascial framework of the pharynx. Passing through the gap are the **pharyngo-tympanic tube** and the **Levator Palati** (accompanied by the ascending palatine artery). The **Tensor Palati,** found here in close contact with the outer side of the Levator, does not pass through the gap as will be apparent in a moment but the two muscles and the tube should be dealt with now.

The **pharyngo-tympanic tube,** as its name implies, joins the pharynx to the **tympanic cavity** and so equalizes air pressure on the two sides of the tympanic membrane. Its direction is backwards, lateralwards and slightly upwards. Pass a fine probe along it in this direction for $1\frac{1}{2}$ inches. Notice that the medial one inch is cartilaginous, the lateral half inch is bony and that where cartilage and bone meet the tube is narrowest and is called the isthmus. The cartilaginous part occupies the fissure between the petrous bone and the greater wing of the sphenoid; this fissure should be re-identified on the dry skull. The observant dissector will want to verify two other points: (1) the cartilage of the tube forms only the upper and medial walls, the lower and lateral walls are membranous; (2) the mouth of the tube rests on a projecting bony spine on the posterior border of the medial pterygoid plate to which it is firmly bound.

The **Levator Palati** and **Tensor Palati** arise close together from the base of the skull, one being on each side of the tube; so one arises from the petrous bone, the other from the sphenoid; and both partly arise from the tube. Both muscles descend to the soft palate, the Levator to elevate the posterior part, the Tensor to depress and render tense the anterior

part. The Levator is as stout as a lead pencil, the Tensor is thin and fanshaped.

Pass the handle of the knife between the Levator and the tube and separate them. Free the tube from the medial pterygoid plate and cut it short. Remove the pharyngo-basilar fascia and expose the origin of the Levator. Divide the Levator, pick away some fat and expose the Tensor.

The Tensor descends lateral to the S. Constrictor and medial pterygoid plate, to the hamulus of that plate. Here it becomes a delicate tendon and 'recurs' round the hamulus to gain the palate where it is inserted into the palatine aponeurosis. Trace the muscle throughout, then read an account of tube, Levator and Tensor.

Lastly by way of review and to maintain your orientation, cut away the soft palate; detach the Superior Constrictor from its continuity with the Buccinator at the somewhat indefinite pterygo-mandibular ligament; leave the Middle Constrictor intact and trace the **Stylo-glossus** and **Stylo-pharyngeus** to their origins from the tip and medial aspect respectively of the styloid process. Remove some fatty tissue and follow the facial artery over the submandibular gland. Observe the Medial Pterygoid passing downwards, laterally and backwards, and the lingual and mylohyoid nerves appearing at its anterior border.

THE MOUTH, TONGUE AND TEETH

Identify by inspection and palpation the **vestibule of the mouth.** It is the region, in general, outside the periphery of the teeth and gums. It alone is accessible to the exploring finger when the teeth are clenched. By exploring the vestibule of his own mouth with his index finger the dissector can feel:

1. The Mentalis, passing from the lower incisive fossa to the skin of the chin.

2. The lower border of the **zygomatic process** of the maxilla and of the **zygomatic arch.**
3. The facial surface of the **maxilla.**
4. The infratemporal surface of the maxilla.
5. The anterior border of the **ramus of the mandible,** the **coronoid process** and the **tendon of the Temporalis.**
6. The **Masseter,** half-an-inch in front of the Temporalis, and rendered prominent when the teeth are clenched.
7. The communication behind the molar teeth between the vestibule and the cavity proper.
8. The pulsation of the **labial branches** of the **facial artery.** (Grasp the lip between finger and thumb.)

With his tongue the dissector can feel:

9. The **frenula** of the lips, the folds of mucous membrane attaching the lips to the jaws in the median plane. The upper one is the more marked.
10. The **labial glands,** immediately deep to the mucous membrane of the lips.

By careful inspection in a good light the orifice of the parotid duct can be made out, usually as a whitish constricted opening, opposite the 2nd upper molar tooth.

Inspect the cavity proper in the cadaver. It is roofed by the hard and soft palates. The soft palate ends medianly in the uvula. Two folds, on each side, arch downwards from the soft palate; the anterior fold, the *palato-glossal arch*, ends at the side of the tongue and marks off mouth from pharnyx; the posterior fold, *palato-pharyngeal arch*, has already been identified and dissected in the pharynx. The palatine tonsil was removed from between the two arches.

Rising from the floor is the anterior two-thirds of the tongue; below the tongue on each side and in front is the **sub-lingual region.** Raise the tongue and observe that its sides and under surface are smooth, and that a median fold, the

frenulum linguae (now probably destroyed), connects the tongue to the floor of the mouth. The **lingual vein** stands out blue and prominent on each side. Lateral to the vein identify a fimbriated fold. On the floor at the root of the frenulum observe the **submandibular duct** opening close beside its fellow of the opposite side. Running backwards and laterally from the opening identify a rounded ridge, the **plica sublingualis,** overlying the upper border of the **sublingual salivary gland.**

With the index finger palpate:

1. The anterior border of the Medial Pterygoid lateral to the palato-glossal arch.
2. The tuberosity of the maxilla behind the 3rd upper molar tooth.
3. The hamulus of the medial pterygoid plate postero-medial to the tuberosity and below the level of the palate.
4. The lingual nerve which, in the living, can be rolled against the jaw medial to the root of the 3rd molar tooth.
5. The lingual artery which, in the living, can be felt pulsating by grasping the fimbriated fold.

Pull the half of the tongue medially. Incise the mucous membrane along the bottom of the furrow between the mandible and the plica sublingualis and, keeping close to the bone, prolong the incision backwards to the 2nd molar tooth and forwards to the frenulum. With the handle of the knife displace the **sublingual gland** (and with it the tongue) medially, but avoid injuring the **lingual nerve** which lies behind the incision. The fossa on the jaw for the sublingual gland is exposed and below it the origin of the Mylohyoid is seen.

Next incise the mucous membrane along the bottom of the furrow between the plica sublingualis and the tongue and,

with the handle of the knife displace the gland laterally. The extensive fan-shaped muscle displayed is the **Genio-glossus** passing from the genial tubercle near the symphysis menti to the tongue. Its medial surface has already been seen. The sublingual salivary gland is enveloped in a sheath of areolar tissue which, like a mesentery, fixes it to the floor of the mouth. The artery to the gland, the **sublingual branch** of the **lingual artery,** reaches it through the "mesentery". Running diagonally across the medial aspect of the sublingual gland and adhering to it is the **submandibular duct.** On teasing between the upper border of the sublingual gland and the plica, about a dozen short ducts are seen leaving the gland to open on the summit of the plica. In front, the gland is in contact with its fellow of the opposite side; behind, it abuts against the submandibular salivary gland; laterally, it occupies the **sublingual fossa** of the jaw; medially, the submandibular duct and the lingual nerve pass between the gland and the Genio-glossus (and Hyoglossus); and the Mylohyoid is below it.

Re-identify the **lingual nerve,** then pick it up close behind the last molar tooth where, now the Superior Constrictor is removed, it can be seen to be clamped to the ramus of the mandible by the Medial Pterygoid. By now it has the chorda tympani incorporated with it. Trace the nerve forwards across the floor of the mouth to the tongue. Where the nerve crosses the Hyoglossus look for two stout but short branches which pass to and suspend the little **submandibular ganglion.** The nerve then describes a spiral round the submandibular duct, lying successively above, lateral to, below, medial to, and finally once more above the duct. Verify the identity of the duct by the fact that it issues from the deep portion of the submandibular gland which lies on the Hyoglossus, below the lingual nerve, and lateral to the submandibular ganglion.

Pick up the **hypoglossal nerve.** It runs forwards between the submandibular gland and the Hyoglossus, well below the lingual nerve. As it crosses the Hyoglossus look for its branches radiating to supply the extrinsic muscles of the tongue; at the anterior border of the Hyoglossus observe that the nerve plunges into the tongue to supply the intrinsic muscles.

Free the sublingual gland from the floor of the mouth and note that the underlying Mylohyoid has a free posterior border around which is wrapped the submandibular gland. The deep portion of the gland—still intact—lies in the mouth; therefore it is from this part that the duct is seen to issue. Examine the attachments of the Mylohyoid and verify that with its fellow it forms a **Diaphragma Oris.**

DISSECTION OF THE TONGUE. Pull the tongue to one side; trace the **Styloglossus** forwards towards the tip, noting its fibers interdigitating with those of the **Hyoglossus.** After displacing the lingual and hypoglossal nerves on the right side, define the anterior border of the Hyoglossus—where the two nerves turn upwards into the tongue. Pass the closed forceps deep to this border, and so raise, cut across and reflect the muscle. This will allow you to follow the **lingual artery** across the Middle Constrictor and Genioglossus; the artery is divided into 3 parts by the Hyoglossus and in this respect resembles the subclavian and axillary arteries. Raise the tip of the tongue and so render tense the **Genioglossi**–they resemble two triangles set vertically with their surfaces applied to each other in the median plane, their apices being attached to the upper genial tubercles. Cut through these apical attachments, keeping close to bone in order not to injure the underlying **Geniohyoidei**–they also resemble two triangles, but horizontally disposed, with their apices attached to the

lower genial tubercles. When the attachments of the Genioglossi are completely severed, the tongue should suddenly become quite mobile and the space between these muscles and the underlying Geniohyoidei can readily be opened backwards with the handle of the knife. Raise the tongue well backwards into the pharynx, therefore exposing: (1) the Geniohyoid extending horizontally backwards to the body of the hyoid bone, (2) the Mylohyoid passing as a sheet from the mylohoid line to meet its fellow below the Geniohyoid. Between the (applied) medial surfaces of the Genioglossi is a median areolar septum already opened. Situated, one on each side under the tongue, in the furrow between the Genio-glossus and the intrinsic muscles is the **anterior lingual gland** about half an inch long; look for it here with the terminal parts of the lingual artery and nerve running above it. Make a cross-section through one half of the tongue and note the *vertical*, *transverse* and *antero-posterior fibers* of its **intrinsic musculature.**

Read an account of the tongue, its structure, muscles, nerves, blood, and lymph vessels.

Examine and read an account of the teeth.

THE LARYNX

The larynx consists of a series of articulating cartilages lined with mucous membrane, and equipped with muscles for the movements of the vocal cords. The 'foundation' cartilage, the **cricoid,** is shaped like a signet ring in that it possesses a plate posteriorly and an arch anteriorly. It bears on its outer surface bilateral facets for the support of the shield-like **thyroid cartilage** above it. At these facets the thyroid cartilage can sway backwards and forwards. On the back of the upper surface of the cricoid is another pair of bilateral facets for the support of two small pyramidal

(tetrahedral) cartilages, the **arytenoids,** which, sitting on the back of the cricoid ring, are capable, (a) of sliding towards one another and away from one another and, (b) of rotating on their triangular bases. Attached at the anterior angles of these triangular bases are the posterior ends of the **vocal ligaments,** whose anterior ends are fixed to the thyroid cartilage, close to one another, near the angle where the two halves of that cartilage meet in the midline in front. Thus the swaying backwards of the thyroid cartilage approximates the two ends of the vocal cords and relaxes them, whilst the converse movement increases the distance between the two ends and renders them tense. The movements of the arytenoids, of course, open or close the aperture between the two cords. Fixed by its point, in the angle between the two thyroid cartilages in front, is a leaf-like cartilage of undetermined function which gives the appearance of a lid for the voice box. It lies at the back of the tongue and is the **epiglottis.**

Inspect the larynx and make out the essential features noted above. If you understand how the movements described above influence the vocal cords the action of each muscle will be evident as soon as its attachments are known.

Notice that the mucous membrane is adherent in front and is loose behind in the arytenoid region. The **internal branch** of the **superior laryngeal nerve** and the **recurrent** (**laryngeal**) **nerve** have been exposed already; follow them with some care. Strip the mucous membrane from around the entrance to the larynx, i.e., from the pharyngeal aspect of the larynx. Clean the **Posterior Crico-arytenoideus:** it arises from the back of the cricoid ring and it is inserted into the muscular process of the arytenoid i.e., the lateral angle of its triangular base. Clean next the **Arytenoideus:** it unites the two arytenoid

cartilages by transverse fibres, superficial to which two sets of oblique fibres form a St. Andrew's cross as they sweep towards the epiglottis, each passing into the ary-epiglottic fold of the opposite side as the **Ary-epiglotticus.**

Define and examine the **crico-thyroid joint** and its three radiating ligamentous bands. Notice it is a synovial joint between a facet on the tip of the inferior horn of the thyroid cartilage and a raised circular facet on the side of the cricoid cartilage. It is behind this joint that the recurrent (laryngeal) nerve courses to enter the larynx.

Inspect the interior of the larynx from above and observe the **vestibular folds** lying supero-lateral to the **vocal folds** (cords). Inspected from below, the vocal folds alone are visible. Saw or cut the thyroid cartilage $\frac{1}{3}''$ to the left of the midline. With the scissors split the trachea, cricoid cartilage and Arytenoideus in the midline behind. If desired, cut the cricoid in front also. Inspect the vestibular and vocal folds. The depression between the two folds is the **sinus** of the larynx and into it opens a recess, the **laryngeal saccule,** whose size and extent should be explored with a blunt probe.

Remove the mucous membrane from the entire left side of the interior of the larynx. To do this, begin by making a horizontal cut along the cricoid cartilage. Strip the mucous membrane from the perichondrium and, working upwards, remove it next from the **crico-vocal membrane.** This membrane is shaped like a truncated cone hence it is sometimes called the **conus elasticus.** It is attached below around the upper edge of the cricoid ring and its free upper edge on each side is somewhat thickened as the **vocal ligament** which forms the basis or supporting ligament of the **vocal fold.** Next remove the mucous membrane from the medial aspect of the arytenoid cartilages. Make a median cut down the epiglottis, remembering the epiglottic cartilage is elastic and soft.

Trace downwards the stalk of the epiglottis. It is attached by means of the thyro-epiglottic ligament, to the thyroid cartilage below its median notch. Peel the mucous membrane laterally, laying bare the **quadrangular membrane.** Observe that this membrane extends between the lateral borders of the epiglottic and arytenoid cartilages and has free upper and lower borders, the **ary-epiglottic** and **vestibular ligaments** respectively; the latter is the basis or supporting ligament of the vestibular fold.

Turn to the outside of the larynx. Define and clean the **Crico-thyroideus** already identified as a detached portion of the Inferior Constrictor; it is the only **extrinsic muscle** the larynx possesses. In order to define the remainder of the **intrinsic muscles** of the larynx cut through the ligaments of the crico-thyroid joint on one side and swing the Crico-thyroideus and lamina of the thyroid cartilage laterally. A more or less continuous sheet of muscle tissue lies revealed, imperfectly subdivided into five parts, and extending from the upper border of the cricoid cartilage to the ary-epiglottic fold that bounds the entrance to the larynx. Its five parts should be investigated from below upwards, they are:

1. **Lateral Crico-arytenoideus,** the strongest mass, applied to the lower part of the vocal membrane and passing from the upper border of the side of the cricoid ring to the muscular process of the arytenoid cartilage.
2. **Thyro-arytenoideus,** above and continuous with (1); applied to the upper part of the crico-vocal membrane and passing between the thyroid cartilage in front, and the lateral border of the arytenoid cartilage behind. Its upper and most medial fibres are the Vocalis.
3. **Vocalis,** applied to the under and lateral surfaces of the vocal ligament.

4. **Thyro-epiglotticus,** consisting of scattered bundles of muscle fibres applied to the quadrangular membrane.
5. **Ary-epiglotticus,** running in the free upper margin of the quadrangular membrane. Its continuity with the oblique fibres of the Arytenoideus has been noted.

The two posteriorly placed muscles, **Arytenoideus** and **Posterior Crico-arytenoideus** have already been dealt with.

Examine the synovial **crico-arytenoid joint** and its movements, then read an account of the larynx, its muscles and their actions.

THE MIDDLE EAR

Exposure of the Tympanic Cavity and Tympanic Antrum. Identify and preserve the stem of the facial nerve below the stylomastoid foramen. Scrape the soft tissues and periosteum off the **mastoid and mastoid process** and also off the posterior root of the zygoma and **supramastoid crest.** Identify the *suprameatal spine* behind the upper part of the meatus. Remove the remains of the cartilage of the meatus until the margin of the orifice of the bony meatus is clean.

With mallet and rounded gouge open the *tympanic antrum* (mastoid antrum). It lies postero-superior to the upper limits of the meatus, is bean-shaped and rather less than $\frac{1}{3}''$ long. Direct the gouge downwards, forwards and medially, i.e., away from the middle cranial fossa and from the sigmoid sinus. (If the ulnar border of the hand holding the gouge is rested on the specimen, the gouge can be controlled when struck with the mallet.) Remove bone, until, at a depth of about $\frac{1}{2}''$ from the surface at the suprameatal spine, the antrum is opened. This is only to be distinguished from an air cell by its position and depth and by the fact that the seeker can be passed forwards (indefinitely) into the *epitympanic recess*, i.e., the part of the tympanic cavity

above the level of the ear drum. Pass the seeker into the recess and, having now established the correct depth, remove bone from the periphery of the region, bevelling it in order to obtain more room to work. With the seeker in place, break down the outer wall of the *aditus* leading from epitympanic recess to antrum.

On the medial wall of the aditus you will see smooth bone covering the *lateral semicircular canal.* Observe now the shape, direction, length, curvature and other features of the *bony meatus.* It is constricted near the *tympanic membrane* (ear drum), whose direction also note. Leave the floor of the meatus intact. Break down its anterior and its posterior wall as far as the attachment of the tympanic membrane. Then, with the point of a sharp knife, incise the membrane round its periphery and carefully pick it out by placing one blade of the forceps on each side of it. With it the *malleus* certainly, and the *incus* probably, will come away. These are two of the tiny ossicles of the middle ear cavity; the *stapes* is the third. Save and study them. Inspect the dissected specimen. Its features verge on the microscopic, so a lens is of great assistance. You can make out at least the following features: *promontory*, an elevation on the medial wall; *stapes* in position in the *oval window*, with its cup-shaped facet for the incus facing you; *stapedius tendon* about 1 mm. long passing to the stapes from the *pyramid*, the cone-shaped elevation behind the promontory from which the tendon emerges; the smooth bone covering the *lateral semicircular canal* as distinct from the trabeculated wall of the *epitympanum:* the rounded wall of the *facial canal* curving backwards and then downwards between the stapes and the lateral semicircular canal.

Break through the outer wall of the mastoid process and note the depth to which the mastoid air cells extend. Scoop them away, working your gouge always in a vertical direc-

tion, in order not to break through the inner bony plate which projects in relief and is the *lateral wall of the sigmoid sinus.* Hold the specimen to the light and observe how thin is this wall. If you are sufficiently interested, trace the course of the facial nerve by opening the outer wall of its canal. This lies between the mastoid cells and the tympanum in the block of bone that is still intact. At least trace the course of the nerve in imagination.

If you care to strip the dura from the *arcuate eminence* and file or pare off thin slices of bone with the chisel, you will break into the *superior semicircular canal.* (You can identify it by the two cut-ends appearing as two minute foramina.) Similarly, by paring off thin slices of the posterior surface of the petrous bone medialwards (from a point $\frac{1}{3}''$ medial to the sigmoid sinus), you will split the *posterior semicircular canal* longitudinally, because this canal is nearly parallel to this surface.

Apply the seeker, or a small chisel, to the floor of the middle cranial fossa just medial to the petro-squamous suture and break through the thin roof of the middle ear, the *tegmen tympani*, which is about 4 mm. wide. Then, nibbling forwards and backwards, reveal from above the *antrum*, *aditus*, *tympanum* and *pharyngo-tympanic tube.* Pass a fine flexible probe from the pharynx along the tube to the tympanum, noting where it enters.

CHAPTER VII

THE BRAIN

Care of the Brain. When the brain is removed from the cadaver its own skull-cap should be placed upon it and the two inverted and immersed for 24 hours in 10 per cent formalin contained in a two-gallon crock—the skull-cap maintains the normal shape of the brain. At the end of 24 hours the skull-cap should be discarded and the brain allowed to rest, in the formalin, on a cushion of cotton waste for 10 to 14 days. Thereafter it should be washed in running water, in order to free it of formalin, and kept in a bland saline solution (e.g., 4 ounces of common salt to 1 gallon of water) until it is to be dissected. Brains dry out rapidly in air, turn brown and hard and, once dry, can never be restored. Keep, therefore, beside you a piece of cheese-cloth soaked in fluid and, with this, moisten the brain from time to time. At the end of each day's work replace the brain in the porcelain crock provided and see that it is well covered with fluid.

Instruments. You will rarely require the blade of the knife; the handle is much more useful. Wooden tongue-depressors cut to various widths and sand-papered smooth, one or two orange sticks for more delicate work, a pair of small blunt-pointed scissors and a pair of blunt-pointed forceps complete the list of required instruments.

Desiderata. It is assumed that you have beside you not only this handbook, but in addition a suitable, well illustrated text-book of Neurology, to which you should constantly refer for detailed accounts of the structures as they

are displayed. It is further assumed that you have some familiarity with the anatomy of the interior of the base of the skull and of the dura mater, since these parts are not here available to you. It is desirable to have available a median section of the brain (possibly a mounted specimen) as well as coronal and horizontal sections, which you should from time to time, consult.

Subdivisions of the Brain or Encephalon

The following brief summary of the development of the brain should be read and understood before dissection begins. For a more detailed account the student is referred to his text-book.

The brain and spinal cord develop from a simple hollow tube closed at both ends. The inferior or *caudal* portion becomes the **spinal cord**; this largely retains its tubular form, but the walls increase greatly in thickness, whereas the lumen is reduced to form the **central canal.** On the other hand, the superior or *rostral* portion, by a process of irregular thickening of its walls and dilatation of its cavity, early becomes differentiated into three well-defined parts, the three *primary vesicles.* From rostral to caudal these are: the **prosencephalon** (Gk. pros = before) or fore-brain, the **mesencephalon** (Gk. mesos = middle) or mid-brain and the **rhombencephalon** or hind-brain, so called because its floor is rhomboidal or lozenge-shaped. The prosencephalon next undergoes a further differentiation so that its superior or rostral part becomes the **telencephalon** (Gk. tele = far away; cf. telephone) and its inferior or caudal part the **diencephalon** (Gk. dia = through or between; cf. diaphragm). By a marked evagination of its lateral walls the telencephalon gives rise to the two **cerebral hemispheres (cerebrum** L. = brain) which ultimately become so large as to overshadow completely the rest of the brain and to hide the diencephalon entirely from view.

The cerebral hemispheres are recognizable, then, as two bilateral masses comprising by far the greater part of the brain; they present obvious ridges or **gyri** and furrows or **sulci** on their surfaces. The surface layer of the cerebral hemisphere, consisting mainly of nerve cells and non-myelinated fibers, varies in thickness from 1 to 4 mm. and is known as the **gray matter** or **cortex.** Beneath this surface layer are the myelinated nerve fibers, largely constituting the **white matter,** and imbedded in the depths of this are large collections of nerve cells known as the **basal nuclei.** In Neurology the word "nucleus" (L. dim. nux = a nut) is frequently used to refer to a collection of nerve cells.

With the bilateral evagination of the telencephalon its cavity necessarily becomes bilateral also; thus, to the single midline cavity of the telencephalon are added the right and left (i.e., the first and second) **lateral ventricles.**

The diencephalon undergoes no evagination, but remains fixed in the midline. Its lateral walls thicken markedly to form two important nuclear masses, the right and left **thalami,** and its cavity is reduced to a deep cleft, the **third ventricle.** The pathway to and from the telencephalon lies applied to the lateral aspect of each thalamus.

Similarly, the mesencephalon or **midbrain** retains much of its primitive form. Through it run fiber tracts to and from higher levels and its tubular cavity is known as the **cerebral aqueduct** (of Sylvius).

The rhombencephalon consists of two parts, the **metencephalon** (Gk. meta = beyond; cf. metacarpal) rostrally and the **myelencephalon** (Gk. myelos = marrow) or **medulla oblongata** (L. medulla = marrow) caudally. The metencephalon is further divided into a ventral portion, the **pons** (L. pons = a bridge) and a dorsal portion, the **cerebellum** (L. dim. of cerebrum). Unlike the cerebrum, the cerebellum contains no cavity for it is a bilateral expansion of the

thickened walls of the rhombencephalon. It is recognizable by its size and by the lamina-like nature of its gyri. The rhomboid-shaped cavity of the rhombencephalon is the **fourth ventricle.**

The mid-brain, pons and medulla oblongata may be referred to collectively as the **brain stem.**

Having understood these fundamental facts of development begin your examination with:

Preliminary Inspection of the Brain

The brain you receive still possesses two of its coverings or **meninges,** the **arachnoid mater** and the **pia mater;** these you will investigate later. Without disturbing these coverings, proceed to make out the major divisions of the brain so that subsequent instructions will be understood. Look at the inferior or basal surface first. There, the cut **spinal cord** is readily identified; follow it rostrally (i.e., towards the fore-end of the brain) noting that it passes imperceptibly into the **medulla oblongata,** which is about $\frac{3}{4}''$ long and which ends at the lower border of the **pons.** This latter is recognized as a prominent transverse bridge of fibers, 1″ or more deep (rostro-caudally) and sinking laterally into the **cerebellar hemispheres** as the **middle cerebellar peduncles.** At the rostral or upper border of the pons the **hind-brain** ends and the **mid-brain** begins, but all that can be seen of the mid-brain at this stage are the rope-like right and left **cerebral peduncles** ($\frac{1}{2}''$ wide at the rostral border of the pons) which diverge as they ascend to the fore-brain. Together they constitute the postero-lateral boundaries of the **interpeduncular fossa.**

The fore-brain or prosencephalon has as its most conspicuous feature the two **cerebral hemispheres,** a right and a

left, separated from each other by the longitudinal fissure which lodges the falx cerebri when the brain is in situ.

Each hemisphere has three surfaces, three poles and three borders. Of the three **surfaces**, the *medial surface*, not at present available for examination, is flat, applied to the falx cerebri, and joined to its fellow at the bottom of the fissure in rather less than half of its length by the **corpus callosum;** the *supero-lateral surface* is large and convex; the *inferior surface* (as reference to the skull will make clear) rests partly on the floor of the anterior cranial fossa and, therefore, is concave and only one quarter of the total inferior surface; the other three quarters rests on the middle cranial fossa and tentorium cerebelli. The transverse cleft on the inferior surface, occupied in life by the posterior border of the lesser wing of the sphenoid, is the **stem of the lateral sulcus.** The petrous portion of the temporal bone fits in the obliquely running concavity in front of the cerebellum.

Of the three **poles,** the *frontal pole* is at the anterior end of the hemisphere and is rounded; the *occipital pole* is at the posterior end and is more pointed; the *temporal pole* is at the antero-inferior end and is also rounded.

Of the three **borders** the *supero-medial border* separates the supero-lateral surface from the medial; the *infero-lateral border* separates the supero-lateral surface from the inferior; and the *infero-medial border,* in front and behind, separates the inferior surface from the medial, but, in its intermediate portion sweeps round the **mid-brain.**

Relations of the Brain to Cranial Cavity

Proceed now to investigate the relations the parts of the brain bear to the containing cranial cavity. Therefore, have a skull beside you and either actually or in imagination replace the brain in the cranial cavity and make out the following

relations, but do not injure the brain by needless manipulation:

1. The **frontal lobe** lies in the anterior cranial fossa. It is separated from the orbital cavity by a thin plate of bone.

2. The **olfactory tract and bulb** (about $1\frac{1}{2}''$ long) lying in contact with the inferior surface of the frontal lobe $\frac{1}{3}''$ from the median line and consisting of a narrow stalk with a slightly bulbous end, rest on the cribriform plate of the ethmoid and thus lie above the roof of the nasal cavity.

3. The region of the **interpeduncular fossa** lies over the median part of the middle cranial fossa.

4. The **temporal lobe** rests on bone (in the middle cranial fossa) in front of the superior border of the petrous temporal bone; behind this border the remainder of the lobe and the **occipital lobe** rest on the tentorium cerebelli beneath which is the cerebellum. The **temporal pole** lies under shelter of the lesser wing of the sphenoid.

5. The **pons** and **medulla** rest upon the inclined surface formed by the dorsum sellae and basi-occiput.

6. The **cerebellum** occupies the remainder of the posterior cranial fossa.

7. When the skull-cap is in place, notice that the **superolateral surface** of each hemisphere is sheltered by the frontal, parietal, temporal (squama) and occipital bones.

Meninges or Coverings of the Brain

When the brain was removed from the cranial cavity the duro mater was left behind. (The dura and its sinuses were studied with the cranial cavity.) Study now the **arachnoid mater.** It is a thin, delicate and transparent covering, separated from the dura merely by a capillary space, the **subdural space.** It is probable that the arachnoid was torn in various places during the removal and subsequent handling of the

brain; therefore, do not expect to find it intact, but with careful observations verify the following facts:

1. The arachnoid affords a complete investment for the brain.

2. It is not carried into the sulci of the brain but bridges over them as, indeed, it bridges over other inequalities of surface. The falx cerebri and lesser wing of the sphenoid do, however, carry it before them into the longitudinal fissure and lateral sulcus respectively.

3. Deep to the arachnoid is a space, the **subarachnoid space,** particularly capacious where inequalities of surface are greatest. The space is filled with fluid, the **cerebro-spinal fluid,** which bathes the surface of the brain.

4. The largest of these spaces or cisterns, and the most important, is the **cerebello-medullary cistern;** it occupies the wide interval between the inferior surface of the cerebellum and the posterior surface of the medulla. Here the nature of the arachnoid may be studied to advantage. Other cisterns are the *pontine* and *interpeduncular cisterns* and the *cistern of the stem of the lateral sulcus.* The cisterns act as fluid cushions on which the brain rests; they intercommunicate freely and extend along the sulci.

5. Connecting the arachnoid to the **pia mater** (which closely invests the brain) across the subarachnoid space are many fine filaments or threads Open into the space between two adjacent gyri and see them. It is these web-like filaments that give the arachnoid its name (Gk. arachnē = a cobweb).

6. Within the subarachnoid space are found the larger arteries and veins.

Two other facts you should note, though probably you will be unable to verify them now:

7. In certain localities—notably on each side of the

superior longitudinal sinus—cauliflower-like projections of arachnoid $\frac{1}{3}''$ or so in diameter, the **arachnoid granulations,** are met with. These project into lateral expansions of the venous sinuses and over them the dura is thinned out. They are but macroscopic aggregations of the more numerous (and more normal) microscopic **arachnoid villi** everywhere present in association with the sinuses and returning cerebro-spinal fluid to the venous stream.

8. A median and two lateral **apertures** exist in the roof of the fourth ventricle (the most caudal of the brain cavities) to allow the fluid secreted into the ventricles to escape into the cerebello-medullary subarachnoid cistern.

The **pia mater** clothes the brain substance like a delicate skin. At the summit of a gyrus it is so intimately laced to the arachnoid by trabeculae as to be inseparable from it. In the depths of a sulcus it alone invests the brain substance. Tubular prolongations of the pia are carried into the brain tissue by the entering finer arteries, thus bringing the interstitial spaces of the brain substance into communication with the cerebro-spinal fluid. The pia, as it is carried inwards, finally gives place to, or becomes, the **neoroglia,** i.e. the supporting tissue of the brain.

Veins of the Supero-Lateral Surface

Without removing arachnoid, identify the **superficial middle cerebral vein** occupying the line of the lateral sulcus. Above this level are the **superior cerebral veins,** draining mainly upwards into the superior sagittal sinus. Below this level are the **inferior cerebral veins,** also largely draining upwards but into the superficial middle cerebral vein, and in part downwards into the sinuses at the base of the skull. The superficial middle cerebral vein ends anteriorly in the cavernous sinus. Posteriorly, a **superior** and an **inferior anas-**

tomotic vein connect the superficial middle cerebral vein with the superior sagittal and the transverse sinuses respectively. The veins of the base of the brain, as well as those on the medial surface, cannot well be investigated now, but you should read an account of them. They are (a) the **deep middle cerebral vein,** occupying the depth of the lateral sulcus and anastomosing with (b) the **anterior cerebral vein,** occupying the depth of the longitudinal fissure, to form (c) the **basal vein** which passes backwards round the cerebral peduncle to end in the **great cerebral vein** (of Galen) to be seen later.

The Cortical Arteries and the Cranial Nerves

These must be studied, or at least dissected, together, otherwise one or other will suffer. It is well to pay particular regard to arteries on the right side and to cranial nerves on the left.

Remove the remains of the arachnoid from the base of the brain by freeing it and snipping it away bit by bit with scissors—not by peeling it off. Exercise great care, for the cranial nerves issuing from the brain stem are much more delicate than your experience of peripheral nerves might lead you to imagine. On the left side, arteries may be cut short if necessary. The good dissector, however, will succeed in preserving arteries and nerves on both sides. Caution: in following any artery do not lift it from its bed.

Begin with the cut ends of the **vertebral arteries.** They are seen coming together and uniting at the lower (caudal) border of the pons to form the medianly placed **basilar artery** and are usually unequal in size. Clean each vertebral artery carefully and identify the **posterior inferior cerebellar artery.** This is the largest branch of the vertebral and curves backwards round the medulla, passing first between the delicate

fila or rootlets of **N. XII (hypoglossal)** and then usually behind those of **NN. X** and **IX (vagus** and **glossopharyngeal)**. If the medulla and cerebellum be gently separated from one another, the tortuous course of the artery can be followed to where it divides into medial and lateral branches on the inferior surface of the cerebellum. This vessel (or the vertebral itself) provides a small thread-like branch, the *posterior spinal artery*, which descends on the spinal cord along the line of the posterior nerve roots. Shortly before the vertebrals unite, each gives off another thread-like artery, the *anterior spinal artery*, which, uniting with its fellow near the lower limits of the medulla, forms a stem occupying the antero-median sulcus of the spinal cord. In this part of the dissection, then, you have identified, cleaned and preserved the fila of NN. XII, X and IX. **Nerve XI (accessory)** consists of a *bulbar portion* and a *spinal portion*. The fila of the bulbar portion are in series with those of N. X, and are immediately caudal to them. The fila of the spinal portion issue from the side of the cord midway between the lines of the anterior and posterior nerve roots. Only if the cord has been cut long will these fila be found.

Now follow the **basilar artery,** lying in the midline of the pons, to its bifurcation into the right and left **posterior cerebral arteries.** Identify the branches of the basilar: (1) **Anterior inferior cerebellar**; smaller than the posterior, runs near the caudal border of the pons. As this artery is traced laterally, notice that it passes in front of **N. VI (abducent),** which it clamps to the pons, and further laterally either above or below **NN. VII** and **VIII** (facial and auditory). (2) **Internal auditory artery;** a long slender vessel arising either from the anterior inferior cerebellar or just rostral to it and destined for the inner ear. (3) **Superior cerebellar**

artery; arising near the rostral border of the pons, just before the basilar bifurcates. At first it runs parallel to the larger terminal posterior cerebral artery; it is distributed to the superior surface of the cerebellar hemisphere. Between it and the posterior cerebral artery pass **N. III (oculomotor)** and more laterally **N. IV (trochlear)**. This latter nerve has come round the cerebral peduncle from the dorsal aspect of the mid-brain, hence its point of exit from the brain cannot be seen now; it is a long slender nerve. (4) **Posterior cerebral artery,** the large terminal branch of the basilar. It runs round the mid-brain and, somewhat obscured from view by the cerebellum, gains a deep sulcus, the calcarine sulcus, where it divides, as the sulcus divides, into *posterior calcarine* and *parieto-occipital.* Observe that the posterior cerebral artery is joined to the corresponding internal carotid artery (whose cut end is seen lateral to the interpeduncular space) by a vessel variable in size, the *posterior communicating artery.*

Turn now to the **internal carotid artery.** You see only the end part of this artery, the part just before its point of division into two terminal branches. The smaller terminal branch, the **anterior cerebral artery,** seeks the longitudinal fissure. To gain this, it runs forwards and medially above the **optic chiasma** (i.e., the prominent transverse bundle of fibers at the fore part of the interpeduncular space) and is joined to its fellow across the median plane by a very short arterial bar, the **anterior communicating artery.** Gently separate the lips of the longitudinal fissure, see the communicating artery, but do not follow the anterior cerebral artery any further. The larger terminal branch, the **middle cerebral artery,** passes laterally in the stem of the lateral sulcus and then backwards in the posterior limb of the sulcus.

Its branches may be seen curling over the lips of this limb to supply the supero-lateral surface of the hemisphere. Do not try to follow the vessel.

Review the formation of the **arterial circle** (Willis) at the base of the brain, then observe the following generalizations: (1) Each of the three cerebral arteries is distributed in the main to one cerebral surface and one pole. Thus: (a) anterior cerebral to medial surface and frontal pole; (b) middle cerebral to supero-lateral surface and temporal pole; (c) posterior cerebral to tentorial surface and occipital pole. (2) If you have been careful not to disturb any artery from its bed, you will see that each of the three cerebral arteries furnishes one set or more of very fine twigs which plunge into the substance of the brain to supply deeper parts. These are the **central branches,** in contra-distinction to the cortical branches already followed. Of them try to make out: (1) *pontine*, a series of fine twigs entering the pons from the basilar; (2) *postero-medial* between the cerebral peduncles, and *postero-lateral* on the sides of the peduncles, from the posterior cerebral; (3) *antero-median*, from the beginning of the anterior cerebral; (4) *antero-lateral,* from the beginning of the middle cerebral. It is the sieve-like appearance of the brain surface produced by these vessels that gives the names **posterior perforated substance** to the area pierced by the postero-medial central vessels and **anterior perforated substance** to the area pierced by the antero-lateral central vessels and lying in the angle between optic nerve and tract. These central branches are long and slender, hard to make out, but important.

If you have followed instructions carefully, you have already identified most of the twelve pairs of cranial nerves. Their points of exit from the brain, (*superficial origins*), should be carefully noted. The cut ends of **N. II (optic)**

are seen at the extremities of the already identified optic chiasma. **Nerve V (trigeminal),** the largest of the cranial nerves, pierces the pons well laterally as a coarse bundle and its site is used to mark the transition from pons to middle cerebellar peduncle. **Nerves VII** and **VIII** make their exit close together; they appear at the lower border of the pons vertically caudal to N. V. Of the two, N. VIII is much the larger and the more lateral; between it and N. VII the observant dissector will notice the small *nervus intermedius.* All three appear at first sight as one cranial nerve, but in reality they are not functionally related.

A few other structures at the base of the brain remain to be identified before the cerebral hemispheres are examined. Thus, immediately in front of the **posterior perforated substance,** which lies in the median plane between the two diverging cerebral peduncles, two small rounded elevations, the **mammillary bodies,** are apparent. In front of the mammillary bodies is a small field of gray matter, the **tuber cinereum,** from which a stalk, the **infundibulum,** descends. This terminates in a little body, the **hypophysis cerebri (pituitary body),** which, however, was left behind when the brain was removed from the skull; the cut stalk is obvious. The gray field is bounded in front by the **optic chiasma** from which the **optic tracts** may be seen encircling the cerebral peduncles.

On each side of the mid-ventral line of the medulla there is a conspicuous longitudinal column, known as the **pyramid.** Lateral to each pyramid and separated from it by the fila of N. XII an oval eminence, the **olive,** is seen.

Removal of the Meninges

The arachnoid at the base of the brain has by this time been removed. Turn to the supero-lateral surface of the cerebral

hemisphere and remove the pia and arachnoid together. With the forceps pick up the arachnoid between two adjacent gyri at a convenient point on the supero-medial border, and, working with forceps and scissors, incise the meninges from the frontal pole to the occipital pole along this border. Use blunt-pointed scissors and be careful not to injure the brain tissue. If now the meninges be grasped between fingers and thumb, they may be gently and slowly peeled off, almost as a complete sheet, as far as the **posterior limb of the lateral sulcus.** Do not attempt to remove them from the sulcus yet. As the peeling proceeds you will meet some of the larger twigs of the vessels lying in the various sulci; withdraw these with care so as to avoid injury to the brain—they may require to be cut with scissors.

In the same manner incise the meninges along the infero-lateral border and reflect them upwards to the lateral sulcus.

Separate the lips of the posterior limb of the lateral sulcus and gently withdraw the meninges, carrying them towards the stem of the fissure. With them the middle cerebral artery, accompanied by the **deep middle cerebral vein,** will also be withdrawn. Cut the vessels and meninges and discard them.

As the procedure is carried out, you will obtain a view of the sunken portion of the cortex known as the **insula.** Further, you will have an opportunity to see once more the *antero-lateral* set of **central arteries.** Carry out this dissection on both cerebral hemispheres, but, for the present, leave the medial surfaces undisturbed.

Before the meninges on the inferior surface of the cerebral hemisphere can be satisfactorily removed it is desirable to separate the cerebellum, pons, and medulla from the rest of the brain by cutting through the mid-brain. Proceed as follows: Cut the basilar artery just before it divides, i.e., between

the superior cerebellar and posterior cerebral arteries; take care of the trochlear nerve. Gently lift the cerebellum slightly away from the cerebrum and without tearing brain tissue. Starting at the rostral border of the pons immediately caudal to (behind) the point of exit of the oculomotor nerve, and, keeping the blade of the wet knife parallel to the tentorial surface of the cerebral hemisphere, cut, with one seeep, through one half of the mid-brain. Repeat the procedure on the other side. Now lift up the back of the cerebellum which by now is much more mobile, see the meninges passing deep to the posterior end of the corpus callosum and cut them close to the cerebellum. Remove the hind-brain entirely, wrap it in cheese cloth and preserve it in the crock for future study.

Remove the meninges from the inferior surface of the cerebral hemisphere by starting at the infero-lateral border and working medially. When you reach the **choroidal sulcus** where the hemisphere is, as it were, wrapped round the brain stem, cut the meninges free but do not, on any account, attempt to withdraw them from the depths of that sulcus. Indeed, it is better to leave the posterior cerebral artery also in place where it sweeps round the brain stem.

Leave the anterior cerebral arteries also in place so as not to disturb the medial surface of the hemisphere but clear away all the other vessels and leave the base of the brain clean and tidy.

Lobes, Lobules, Sulci and Gyri

Place the thumb on the medial aspect of the occipital pole of the hemisphere and the fingers on the supero-lateral aspect, while the brain is steadied with the other hand; bend the occipital pole laterally, away from its fellow, and the hemisphere will "open up" along a deep sulcus, the **parieto-occipi-**

tal sulcus. This cuts the supero-medial border about 2″ from the occipital pole and extends for $\frac{3}{4}$″ on to the supero-lateral surface. Mark this point on the border. On turning to the infero-lateral border, you see, slightly less than 2″ from the occipital pole, a slight impression, the **pre-occipital notch,** caused probably by some veins entering the transverse sinus where it becomes sigmoid, i.e., where tentorium joins petrosal bone. Mark this notch. A line joining the two marked points across the supero-lateral surface arbitrarily separates the **occipital lobe** behind from the **parietal** and **temporal lobes** in front.

The stem and posterior limb of the **lateral sulcus** have already been identified. The posterior limb turns sharply upwards as it approaches its termination. If, however, the general direction of the posterior limb be continued backwards until it cuts the line previously determined, the surface will be further subdivided into a smaller area below, and a larger area above. The lower area is the **temporal lobe;** the upper one is **frontal lobe** in front and **parietal lobe** behind.

The general direction of the sulci of the supero-lateral surface is roughly antero-posterior; near the middle of the area, however, a group of three parallel sulci runs from the supero-medial border obliquely downwards and somewhat forwards towards the posterior limb of the lateral sulcus. The middle sulcus of the group, the **central sulcus,** is probably the best marked and is uninterrupted in its course. It cuts the supero-medial border about $\frac{1}{2}$″ behind its midpoint, but it usually just fails to reach the lateral sulcus. The anterior of the three parallel sulci is the **precentral sulcus,** whereas the posterior one is the **postcentral sulcus.** The central sulcus divides frontal lobe from parietal lobe; in front of it lies the *motor area,* behind it, the *sensory area.*

The general antero-posterior direction of sulci is a particularly obvious feature of the temporal lobe. It is this parallelism of the two temporal and the two frontal sulci that permits us to speak of *superior, middle* and *inferior, temporal* and *frontal gyri.* (The inferior temporal gyrus is carried around the infero-lateral border on to the inferior surface.)

The lower end of the **parieto-occipital sulcus** unites, on the medial surface of the hemisphere, with another sulcus, the **post-calcarine**, to form the **calcarine sulcus.** This last turns slightly on to the inferior surface where it may be identified by observing, (a) that the stem of the posterior cerebral artery still lies in it, (b) that only a narrow strip of cortex, the **isthmus**, intervenes between it and the posterior end (splenium) of the corpus callosum.

The fissure apparent where the cerebral hemisphere sweeps round the mid-brain is part of the **choroidal fissure.** In its depth a fold of pia, with its contained vessels, invaginates the thin medial wall of the cerebrum and so produces a vascular fold known as the **tela choroidea of the lateral ventricle.** Do not disturb it. The layer of pia covering the posterior aspect of the mid-brain and the layer curving around the posterior end of the corpus callosum meet and are carried forwards below the corpus callosum (and fornix) as a fold, the **tela choroidea of the third ventricle.** The slit-like space into which the fold passes is the **transverse fissure,** the choroidal fissure on each side, being its lateral parts. Although the telae cannot be seen at present, their positions can be appreciated.

On the inferior surface of the cerebral hemisphere lateral to, and parallel to, both the calcarine sulcus and the choroidal fissure is the **collateral sulcus.** The gyrus medial to the collateral sulcus is the **hippocampal gyrus,** the *cortical area*

for smell, and on the antero-medial extremity of this gyrus is a hook-like enlargement, the **uncus**, separated laterally from the temporal pole by the short **rhinal sulcus** (sometimes continuous with the collateral sulcus). Posteriorly, the hippocampal gyrus is considered to end where the calcarine sulcus begins, but it is continued on to the medial surface of the cerebral hemisphere as the **isthmus**, and it is prolonged backwards as the **lingual gyrus.**

The gyrus lateral to the collateral sulcus, the *medial occipito-temporal gyrus*, is bounded laterally by the *occipito-temporal sulcus*, lateral to which in turn is the *lateral occipito-temporal gyrus*. (Is this the inferior temporal gyrus?)

The various sulci possess constant but various values. Some are due merely to the *developmental configuration of the brain*. Thus, the lateral sulcus marks the line along which the hemisphere was folded on itself, the temporal pole representing approximately the original hinder end of the cerebrum. It is in consequence of this folding that a portion of the cortex, the insula, has been covered over. Again, the choroidal fissure marks where the hemisphere has folded itself round the brain stem. In the depths of this fissure is a part of the medial wall of the hemisphere which has remained undeveloped and exceedingly thin. Other sulci occur along lines denoting *functionally different areas*. The central sulcus, for example, separates motor cortex in front from sensory cortex behind. These functional differences are reflected in *structural differences in the cortex* and it is this factor that in part at least may account for folding occurring along these lines. [Usually sulci of this value are deep and may invaginate, and correspond to swellings in, the ventricular cavities.] Because they are significant the student should make himself familiar with most of the sulci already identified.

Insula and Its Opercula

Revert once more to the lateral sulcus. Where the stem passes backwards as the posterior limb there are two short sulci, each about an inch long, running forwards into the frontal lobe. The lower, the **anterior horizontal limb,** separates the **pars orbitalis** below, from the **pars triangularis** above. The upper, the **anterior ascending limb,** separates the **pars triangularis** in front, from the **pars posterior** behind. The pars posterior is important, for in it is the *center for speech*. Thus, four **opercula** (L. = lids) are recognized hiding the insula from view; of these three are above, namely, the **orbital** (pars orbitalis), **frontal** (pars triangularis) and **fronto-parietal** (bounding the posterior limb of the lateral sulcus above). One is below, namely, the **temporal** (bounding the posterior limb of the lateral sulcus below). If these "lids" be opened the insula is revealed.

By a curved incision with a knife guarded $\frac{3}{4}''$ from its tip, remove the frontal and fronto-parietal opercula to a distance extending about one inch above the posterior limb of the lateral sulcus, and $\frac{3}{4}''$ inwards or medially. Leave the "roots" of the opercula intact and, for the present, do not disturb the orbital or temporal opercula at all. The insula thus exposed is surrounded by a triangular sulcus, the **circular sulcus,** having superior, antero-inferior and postero-inferior parts. The three short (frontal) and the two long (parietal) gyri of the insula will be at once obvious. Between them is the **central sulcus of the insula** which, observe, is deep to and parallel to, the central sulcus of the cerebral hemisphere. At the lower lateral extremity of the central sulcus of the insula is an area known as the *limen insulae* (limen = threshold or edge). This limen is continuous with the anterior perforated substance. Observe also that the gyri come to an *apex* in this area. Now observe on the upper surface of the

temporal operculum, which is still in place, the **transverse temporal gyrus.** It belongs to the acoustic area or *center for hearing*.

Association Fibers

Adjacent gyri of the cortex are brought into connection with one another by short U-shaped fibers which sweep round the depth of the intervening sulcus. These are the **short association fibers** to be found everywhere. Break a convenient gyrus, as you would break a piece of bread, and observe them.

Distant parts of the cortex of the same hemisphere are brought into connection with one another by **long association fibers** which necessarily lie deeper. These are gathered together in certain localities into well defined bundles, which are to be dissected now:

1. **Superior longitudinal bundle.** Using a wooden tongue-depressor or the squared handle of the knife as a dissecting instrument, remove bit by bit the "roots" of the frontal and fronto-parietal opercula until you reach a bundle of fibers running antero-posteriorly; the fibers arch, as a ledge, over the superior part of the circular sulcus in the "roots" of these two opercula. By removing brain tissue more widely trace this tract, the superior longitudinal bundle, forwards into the frontal lobe and backwards, where most of the fibers are seen to circle downwards and then forwards, into the temporal lobe. A few scattered fibers pass to the occipital lobe. In order to follow the main bundle it will be necessary to remove the temporal operculum. The good dissector will see certain of the fibers leaving the bundle for these lobes. As the fibers curve behind the insula to run forwards into the temporal lobe, they cross at right angles, and lie immediately superficial to, a deeper set of fibers, the **inferior fronto-**

occipital bundle, which must be left undisturbed; it will be dealt with in a moment.

Remove the cortex of the insula with its short association fibers. This involves less than a depth of 0.75 cm. Beginning posteriorly, endeavor to find a cleavage plane deep to which lies a very thin plate of gray matter known as the **claustrum.** It is perhaps a detached film of the cortex of the insula and is co-extensive with it. It is a little difficult to recognize the claustrum, but the observant dissector will determine it as such by its cellular nature and by the fact that no fibers can be traced in it. Scrape away the claustrum and reveal deep to it the vertically radiating fibers of the **external capsule** of the lentiform nucleus.

Subjacent to the cortex of the limen insulae a prominent skein-like bundle of fibers, the **uncinate bundle,** will be met. Its inferior fibers are U-shaped and sweep sharply from frontal to temporal pole. Its more superior fibers spread out anteriorly into the frontal lobe; followed backwards, they are the fibers already seen passing deep to the superior longitudinal bundle and making their way to the occipital lobe. Follow these fibers to the occipital lobe, removing cortex as you proceed. In doing this, the superior longitudinal bundle has to be, in part, removed. The fibers you have traced forwards and backwards constitute the **inferior fronto-occipital bundle.** You will possibly observe that some fibers pass from temporal to occipital lobe. These are usually designated the **inferior longitudinal bundle.** There exists one other long association bundle, the **cingulum;** it will be dissected later.

Projection or Itinerant Fibers

The cerebral cortex is connected to lower centers by afferent and efferent fibers which are, so to speak, projected to and

from the cortex. They constitute very important pathways and some of them are to be dissected now.

Remove the superior longitudinal bundle entirely. Deep to the external capsule of the lentiform nucleus lies an important gray cellular mass, the **lentiform nucleus**; later you will find that deep to it again are the fibers of the **internal capsule** of the lentiform nucleus, which run parallel to the external capsule but separated from it by the nucleus. Hence the lentiform nucleus is embedded in white projection fibers which form for it a capsule. Above the level of the lentiform nucleus both capsules become a fan-like mass of radiating fibers known as the **corona radiata.** Follow the corona radiata in front of, and above, the level of the lentiform nucleus, removing cortex to trace the fibers as they mount upwards.

Peel off the external capsule (a thin plate of fibers) and so expose the outer surface of the gray **lentiform nucleus.** If this is carefully done, you will have the nucleus framed in front, below and behind by the inferior fronto-occipital bundle and above by the corona radiata which, under the name of the internal capsule, passes medial to the nucleus.

Turn now to the posterior part of the inferior fronto-occipital bundle. Appreciate that this long association bundle lies immediately superficial to two projection pathways; an upper and more dorsal, the **posterior thalamic radiation**; and a lower and more ventral, the **optic radiation.** On peeling away the posterior part of the inferior fronto-occipital bundle, you will, therefore, come upon the finer bundles of these radiations. In doing this, it is necessary to lift up a few fibers at a time and strip them backwards. Now if you proceed cautiously, you will meet fibers that come out from *beneath* the lentiform nucleus and sweep in a sharp curve at first forwards and lateralwards into the

temporal lobe and then abruptly backwards into the occipital lobe. This looped bundle is the true **optic radiation.** Follow it to the occipital lobe where it ends in the cortex of the post-calcarine sulcus; this is the **striate area.** With a sharp wet knife cut off the occipital pole one inch from its tip and observe the division of the striate area into two layers by a thin sheet of white matter, the *visual stria.*

Above the level of the optic radiation it will be seen that the finer fibers, uncovered by the removal of the inferior fronto-occipital bundle, come out from the depths *behind* the lentiform nucleus and pass backwards at once to the occipital lobe. These fibers, the **posterior thalamic radiation,** at first sight appear to be merely the upper portion of the optic radiation. They come, however, from a different source and are not visual fibers. Their uppermost fibers are not covered entirely by the long association bundles. Both radiations are projection pathways.

Medial Surface and Cingulum

The medial wall of the hemisphere still remaining must now be broken down but only as far as is necessary to render accessible the **medial surface** of the undissected hemisphere; this is now to be studied. Remove the meninges and study the sulci and gyri. You have already identified the **parieto-occipital** and **post-calcarine sulci.** The wedge of brain between them is the **cuneus.** The sulcus in which the anterior cerebral artery lies, the **sulcus cinguli,** takes an arched course midway between the supero-medial border and the corpus callosum, which is also arched. Traced backwards, it turns upwards and cuts the supero-medial border ½″ behind the central sulcus, so each sulcus serves as a reliable guide to the other. Behind the upturned end of this sulcus is a quadrate area, the **precuneus,** limited posteriorly by

the parieto-occipital sulcus. In front of the upturned end is the **paracentral lobule**; it receives its name from the fact that the upper end of the central sulcus (usually) cuts the supero-medial border in this lobule. The lobule is not well marked off in front, though another upturned limb of the sulcus cinguli frequently denotes its anterior limit.

The sulcus immediately bounding the corpus callosum is the **callosal sulcus.** Between it and the sulcus cinguli is the **gyrus cinguli,** which turns round the hinder end (splenium) of the corpus callosum and is continuous posteriorly with the hippocampal gyrus through the **isthmus.**

N. B. The anterior cerebral artery does not always confine itself to the sulcus cinguli; its companion vein, the anterior cerebral vein, joins the **deep middle cerebral vein** to form the **basal vein** at the anterior perforated substance.

Remove any remains of the medial surface of the partially dissected cerebral hemisphere downwards as far as the sulcus cinguli and lateralwards for a width of one inch. When the upper surface of the gyrus cinguli is exposed, remove the cortex of this surface until a longitudinally-running bundle, about as thick as a pencil, the **cingulum,** is met in its depth. Follow this bundle forwards and backwards until it is seen to curve around the corpus callosum. Do not trace it on to the inferior surface of the corpus callosum at present. Cut the cingulum near its middle and reflect it backwards and forwards. The upper surface of the corpus callosum, seen at the bottom of the longitudinal fissure, is still covered with a thin veneer of gray matter deep to which may be seen two longitudinal threads of white matter. The gray coat is the *indusium griseum* and the threads are the *medial and lateral longitudinal striae.* The indusium and striae are parts of the *hippocampal rudiment.*

Repeat now the dissection up to this stage on the other cerebral hemisphere. When the two sides are equally advanced in dissection, proceed to the dissection of the corpus callosum. Carry out each subsequent step in dissection on both sides unless advised otherwise.

The Corpus Callosum

is the great white commissure uniting the two cerebral hemispheres. It reaches to within about $1\frac{1}{2}''$ of the frontal pole and $2\frac{1}{2}''$ of the occipital pole. Its thickened anterior extremity, the **genu,** is continued below as a thin lamina, the **rostrum,** into the **lamina terminalis**—the fore end of the primitive brain. Succeeding the genu is the **trunk** or **body.** The thickened posterior extremity is the **splenium.** Fibers from the splenium sweep backwards in a bold curve into the occipital lobes as the **forceps major;** similarly, fibers from the genu sweep forwards into the frontal lobes as the **forceps minor.** Most of the fibers of the trunk cross at right angles to the fibers of the corona radiata. A few, however, lie behind the posterior limits of the corona radiata and arch downwards deep to the fibers of the posterior thalamic radiation. Here, as the **tapetum,** they form the roof and lateral wall of the lateral ventricle in that vicinity. Identify these various parts of the corpus callosum and, by blunt dissection with the orange stick, follow the fibers of the forceps minor and forceps major. Trace the trunk or body to its intersection with the corona radiata and endeavor to follow the tapetum for a short distance deep (medial) to the posterior thalamic radiation.

On the inferior surface of the hemisphere find the **collateral sulcus.** Take hold of the remains of the temporal lobe and "break" it along this line. It will break through along a

natural cleavage plane which is below and lateral to the optic radiation. If this procedure is properly executed, the following parts of the cortex remain: the hippocampal gyrus, the tip of the temporal pole and the striate area of the occipital region.

The Lateral and Third Ventricles

As you carry out the following dissection, be sure to examine your incision from time to time, so that you may avoid injury to structures in the walls and floor of the cavity. Identify the lowest fibers of the optic radiation and insert the point of the probe beneath them. It will enter the **inferior horn of the lateral ventricle.** Draw the point of the probe backwards, in the cavity, along the line of these fibers, towards the occipital region. Now carry a cut upwards across the optic and posterior thalamic radiations, and so open the cavity along the line of the tapetum (where the wall is very thin). Carry the incision to within $\frac{1}{4}''$ of the midline and then run it sagittally through the body of the corpus callosum ($\frac{1}{4}''$ from the midline) far enough forwards to lay open the **body** and **anterior horn.** Enlarge the cut backwards to open the **posterior horn.** By this procedure the optic radiation is left almost completely intact; it may be turned medialwards as desired, to allow the ventricle to be examined. By gently separating the margins of the cut inspect the form and parts of the **lateral ventricle.** Identify: the **anterior horn, body,** and **posterior** and **inferior horns.** Notice that the inferior horn is in reality the continuation of the main cavity into the temporal lobe. Observe the smooth, glistening, pale lining, the **ependyma.** The horizontal roof of the body of the cavity is the corpus callosum. In the sloping floor of the body and anterior horn, identify a succession of structures. From lateral to medial side, and

somewhat from before backwards, these are: (1) the **caudate nucleus,** a smooth, gray, nuclear mass consisting of (a) a large convex *head* so prominent as to form a lateral wall for the anterior horn, (b) a rapidly tapering *body*, lying in the floor of the body of the ventricle and (c) an attenuated *tail* swinging downwards and forwards in the roof of the inferior horn; (2) the **thalamo-striate vein** occupying—with an insignificant fiber bundle, the *stria semicircularis*—the groove which separates the caudate nucleus from; (3) the small lateral area of the superior surface of the **thalamus;** (4) the **choroid plexus of the lateral ventricle** projecting, as a vascular fringe, from under the sharp, free edge of (5) the **fornix** and almost entirely obscuring the thalamus from view.

The anterior extremity of the choroid plexus projects into a small opening, the caliber of a goose-quill, the **inter-ventricular foramen** (of Munro), situated where the anterior horn becomes the body of the ventricle and connecting the lateral and the third ventricles. In front of the opening the fornix passes downwards, as the **anterior columns** on their way to the mammillary bodies. Behind the opening is the anterior extremity of the thalamus. The anterior portion of the medial wall (below the body of the corpus callosum) is thin and is the *septum lucidum.* Further back there is no medial wall identifiable, for the body of the fornix is attached to that of the corpus callosum.

If the handle of ~~the knife~~ be insinuated beneath the splenium of the corpus callosum it can be made to pass forwards and laterally, and will emerge beneath the free edge of the fornix. The handle entered the **transverse fissure** and pierced merely a thin ependymal wall which is attached on the one hand to the edge of the fornix and on the other to the caudate nucleus. In the transverse fissure a fold of pia mater (with contained vessels) is the immediate roof of the

diencephalon and separates it from the body of the fornix. This is the **tela choroidea of the third ventricle;** it will be seen in a moment.

Follow the choroid plexus of the lateral ventricle into the inferior horn. It lies between that part of the fornix known as the **fimbria** below, and the attenuated tail of the caudate nucleus above. Turn to the choroidal fissure, seen on the inferior surface of the cerebral hemisphere, and observe once more that it is but a lateral extension of the transverse fissure, and that it is separated from the ventricular cavity only by an invaginated ependymal wall (in which lies the plexus) also stretching from fimbria to caudate nucleus. Demonstrate this fact by passing a probe from this fissure into the cavity.

The choroidal plexus of the lateral ventricle is supplied by an **anterior choroidal artery** (arteries) from the middle cerebral artery and a **posterior choroidal artery** (arteries) from the posterior cerebral. The one enters the choroidal fissure far forwards; the other, far back; they are important but minute vessels.

When you clearly understand the manner in which the choroidal plexus has come to project into the ventricular cavity, then, but not till then, proceed with the dissection. The plexus bears the same relationship to the ventricular cavity as the intestines bear to the peritoneal cavity.

Cut across the body of the corpus callosum just behind the genu, raise it and, with knife or scissors, sever its connection with the septum lucidum in front and with the body of the fornix behind. As the splenium is approached, again cut across the corpus callosum and remove the free piece. Observe the (potential) cavity between the layers of the septum lucidum, and study the **fornix.** The exposed triangular portion, attached to the under surface of the corpus

callosum is the **body.** Transverse fibers here join the two fornices and constitute the **hippocampal commissure;** in man they are insignificant. From the apex of the triangle the (anterior) **columns of the fornix** have already been seen descending vertically in front of the interventricular foramen. The remainder of the fornix will be seen to better advantage later.

Cut across the body of the fornix at its narrow anterior end, just behind the interventricular foramen, lift it up slowly and cautiously, and gently separate it from the underlying **tela choroidea of the third ventricle.** Turn the specimen over and, on both sides, cut across the brain tissue intervening between the uncinate bundle and the inferior horn of the lateral ventricle and thereby separate the brain into two pieces: (1) the hippocampal formation, with the temporal and occipital poles, and (2) the basal nuclei, diencephalon and part of the midbrain.

Study the **tela choroidea of the third ventricle.** Pick up this triangular fold of pia at its apex, which lies between the two interventricular foramina, and observe that the choroidal plexus of the lateral ventricles, lying in the free margins of the fold, is continuous with its fellow of the opposite side at this apex. Raise and turn the tela backwards, and observe the **thalamo-striate veins** (which must be severed) passing between the layers of the tela and turning backwards close to the midline as the **internal cerebral veins.** The two internal cerebral veins approach one another and ultimately unite to form the **great cerebral vein** (of Galen) which turns upwards behind the splenium and empties into the straight sinus. As the fold is removed, small, finger-like projections may be observed hanging down from it into the cavity of the third ventricle. These constitute the **choroid plexus of the third ventricle** and their removal, with the ependymal

roof, leaves the cavity of the third ventricle exposed. This ependymal roof stretches between the two thalami, and the torn edges of the roof may be seen as the *taeniae* attached to the supero-medial borders of the opposed thalami. Continue turning backwards the tela, being careful not to injure the underlying **pineal gland.** The pineal gland is a small organ, the size of a pea and the shape of a pine cone, lying under the posterior part of the tela and in the interval between the posterior extremities of the diverging thalami. Lastly, remove the tela in its entirety and thereby freely expose the dorsal aspect of the brain stem.

Study the **third ventricle** whose roof is removed. It is a slit-like cavity which widens behind, where the pineal gland reposes, and whose lateral walls are the two thalami and the two hypothalami. The thalami are so closely applied that commonly they adhere over an area the diameter of a pencil, the *massa intermedia.* The lower (ventral) limit of each thalamus is indicated on its medial surface by the **hypothalamic sulcus**; this extends on each side from the interventricular foramen to the central canal of the mesencephalon, known as the **cerebral aqueduct.** Identify the shallow sulcus and the aqueduct.

The anterior wall of the ventricle is the thin **lamina terminalis.** From it the **anterior commissure,** thick as an orange stick, projects into the cavity in relief and crosses at right angles to the **columns of the fornix.** These columns were severed at their junction with the body of the fornix. The floor of the ventricle is also thin; it is part of the **hypothalamic region.** Verify, by inspecting the inferior aspect of the brain, that the floor consists of **optic chiasma, infundibulum** leading to the **hypophysis cerebri, tuber cinereum** and **mammillary bodies.**

You have already learned that the lateral surface of the thalamus is applied to the internal capsule. The caudal surface rests on an inaccessible transition zone known, the **subthalamus.**

Inspect the **epithalamic region.** It comprises: the pineal gland; a little triangular region, the *habenular trigone,* on each side of the stalk of the pineal gland; and two little strands, one on each side, which lie in and emphasize the taeniae and are known as the *striae medullares thalami.* The striae meet in the stalk of the pineal gland. Observe, immediately above the opening of the aqueduct into the third ventricle, a well-marked, but small, transverse bundle (half the size of the anterior commissure), the *posterior commissure.*

Turn the specimen over. The **optic tracts** are readily recognized encircling the cerebral peduncles. The overhanging, free posterior part of the thalamus is known as the **pulvinar** (= a cushion). Under shelter of the pulvinar a small, rather indefinite swelling in which the optic tract mainly ends will be recognized. This is the **lateral geniculate body;** from it the **geniculo-calcarine tract** or optic radiation originates. Establish now the pathway throughout its extent. Medial to the lateral geniculate body is a much better defined swelling, the **medial geniculate body;** it is a cell station on the auditory pathway, and from it the **auditory radiation** originates. The two geniculate bodies are sometimes known as the **metathalamus.** The thalamus, hypothalamus and metathalamus all belong to the diencephalon.

The Olfactory Apparatus

Your dissected specimen has been separated into two portions. The smaller, consisting very largely of the olfactory apparatus, must be studied now. (You can at any time reestablish its relations to other parts by fitting together the

two portions as they originally existed.) Identify the **hippocampal gyrus** and the **uncus.** Observe that this gyrus, visible on the inferior surface of the cerebral hemisphere, corresponds to a swelling in the floor of the inferior horn of the lateral ventricle; from its fancied resemblance to a sea-horse this swelling is known as the **hippocampus.** It appears quite white since its surface consists of a plate of fibers, the **alveus.** These fibers gradually gather together medially as a flat bundle, the **fimbria** of the fornix, which sweeps, as the **crus,** upwards and then forwards in a bold curve to approach its fellow. They meet and form the **body of the fornix.** Posteriorly this body is wide, and in man the transverse (commissural) fibers, already observed passing from one side to the other as the *hippocampal commissure,* are insignificant,—a little stroking transversely may be necessary to display them. At the anterior swollen end of the hippocampus, a number of (*hippocampal*) *digitations* may be seen on its lateral side.

Between the fimbria of the fornix and the hippocampal gyrus there is a slit-like interval, the *hippocampal sulcus;* in its depths may be seen a narrow strip of gray matter with a scalloped margin, the *dentate gyrus.* Followed posteriorly, this gyrus is seen to turn round the splenium of the corpus callosum to reach the upper surface of that body. Here it is sometimes called the *splenial gyrus,* and it becomes continuous with the already identified *indusium griseum* which has been destroyed. The fibers in this little rudimentary gyrus, also destroyed, are the *medial and lateral longitudinal striae.* The two gyri, the indusium and the striae together are known as the *hippocampal rudiment* which turns round the genu of the corpus callosum to the region of the anterior perforated substance.

Turn to the other portion of the brain. Peel off the anterior portion of the fronto-occipital bundle and the uncinate

fasciculus (if not already done) and fully expose the outer surface of the lentiform nucleus. On the right side only, shell out the nucleus, then clean and study the lateral surface of the **internal capsule.** It is not difficult to understand that what was originally a single mass of gray matter, the basal nucleus, has become split by the internal capsule into two nuclei, lentiform and caudate, which, however, remain undivided antero-inferiorly at the anterior perforated substance. As these antero-inferior fibers of the internal capsule are being traced and cleaned caudally, you will come across a distinct compact but narrow bundle of transverse fibers lying above (deep to) the anterior perforated substance. This bundle has already been recognized as the **anterior commissure.** Follow it from one temporal lobe to the other and note that it is embedded in the lower surface of the undivided nuclear mass.

Gently free the median portion of the anterior commissure; this will rupture the lamina terminalis, the anterior wall of the third ventricle. On each side of the opening just made you will see a bundle of fibers, similar in appearance to the anterior commissure but running above and at right angles to it. This bundle is the **anterior column of the fornix** proceeding to the mammillary body. It runs at first vertically downwards in front of the interventricular foramen and then curves backwards, embedded in the lower part of the lateral wall of the third ventricle. It will be followed to the mammillary body later.

The Mesencephalon

Your cut through the mesencephalon, whereby you first divided the brain into two parts, probably passed between two pairs of rounded eminences known as the **corpora quadrigemina.** It will, therefore, be necessary for you to refer to

the undissected specimen you put away, as well as to the one immediately before you. By fitting together the two parts you should encounter no great difficulty. Your examination will be aided if you first remove the meninges from the cerebellum in the region where the dorsal aspect of that organ is wrapped round the midbrain.

On the dorsal aspect of the mid-brain identify four rounded elevations, the **corpora quadrigemina,** known also as the *superior* and *inferior colliculi.* On the lateral aspect, trace from them the **superior** and **inferior brachia** or arms, leading to the **lateral** and **medial geniculate bodies** respectively. The inferior brachium is the more obvious, whereas the superior brachium intervenes between the medial geniculate body and the **pulvinar** (i.e., the overhanging posterior extremity of the thalamus). Caudal to the inferior colliculus, a wide plate of fibers, the **superior cerebellar peduncle** (brachium conjunctivum), may be observed coming from the interior of the cerebellum and plunging deeply into the mid-brain beneath the inferior colliculus. The superior cerebellar peduncles approach one another rostrally and stretching between them is a thin lamina, the **superior medullary velum.** At the apex of the velum a short median band, the *frenulum veli* is conspicuous. On each side of the frenulum, nerves IV (trochlear) make their exits, after having decussated in the velum. Lateral to the superior cerebellar peduncle may be seen another but much less obvious plate, the **lateral lemniscus,** which passes obliquely upwards and backwards to enter the medial geniculate body and the inferior colliculus; its fibers belong to the auditory pathway. A groove separates the lateral lemniscus from the **basis pedunculi** which occupies the antero-lateral aspect of the mid-brain. The basis consists of fiber tracts continued downwards from the internal capsule as a compact bundle.

The **cerebellum, pons** and **medulla** are arranged around the fourth ventricle whose floor is rhomboidal, hence this part of the brain is called the rhombencephalon.

The Cerebellum

Remove the meninges and blood vessels from the remainder of the cerebellum, from the pons, and from the medulla. If you are careful you will succeed in doing this without injury to the superficial origins (i.e., the origins from the surface of the brain) of cranial nerves IV to XII.

The cerebellum consists essentially of a median portion, the **vermis**, and two lateral masses, the **cerebellar hemispheres.** The vermis is demarcated only on the inferior surface where it lies in a deep cleft, the *vallecula;* on the superior surface the vermis passes laterally, without clear line of demarcation, into the cerebellar hemispheres. A thin tongue of the vermis, the *lingula*, lies on, and tends to adhere to, the superior medullary velum which forms the rostral portion of the tent-like roof of the fourth ventricle. If the vermis be traced around from the lingula, it can be appreciated that it forms almost a complete circle, its other extremity, the *nodule*, lying on the inferior medullary velum which forms the caudal part of the roof of the fourth ventricle. The nodule lies so deeply placed that it is scarcely possible to see it at present. Where the middle cerebellar peduncle plunges into the interior of the hemisphere, a small portion of cerebellar cortex may be seen partially embracing it caudally. This is the **flocculus.** It lies immediately caudal to N. VIII. The observant dissector will further notice that the flocculus is continuous medially with a thin lamina, the *inferior medullary velum*, which connects it to the nodule. These three together form the **flocculo-nodular lobe;** it will be seen to better advantage later. The little rudimentary *para-*

flocculus lies posterior to, and in contact with, the flocculus. The prominent part of the vermis which lies in the vallecula (sometimes known as the *pyramid* and *uvula*), together with the right and left *paraflocculi,* constitutes the **posterior lobe** of the cerebellum.

By far the greatest mass of the cerebellar hemispheres forms the **middle lobe.** This is separated from the much smaller **anterior lobe** by the morphologically important **primary fissure.** This fissure lies transversely disposed about half way down the superior aspect of the vermis. It is often not the most obvious fissure.

The middle lobe is subdivided into the following lobules: (1) *simple lobule* (unpaired) extending right across the superior surface of the hemisphere immediately behind the primary fissure, and in front of the next most noticeable fissure (it is butterfly-shaped and about ½″ in depth in its middle part but wider laterally); (2) *medial lobule* (unpaired) consisting of the parts of the vermis between the simple lobule and the posterior lobe; (3) *anso-paramedian lobule* (paired) occupying the parts of the hemisphere not already classified. It will be obvious that this is a very extensive lobule.

There are three **cerebellar peduncles.** The superior and middle have already been identified. The inferior, or **restiform body,** connects the cord and medulla to the cerebellum. It is seen on the lateral aspect of the medulla on a plane immediately behind the rootlets of NN. IX, X and XI. Passing upwards it turns sharply backwards, embraced by N. VIII, and it sinks into the cerebellum in close proximity to the middle peduncle. Do not disturb it now but appreciate that it occupies a position between the other two peduncles. The majority of its fibers end in the anterior lobe.

Begin dissection of the cerebellum on its dorsal or superior aspect by following the **middle cerebellar peduncle** into the

cerebellum. This is easily accomplished by peeling away with the finger tips, as much of the cerebellar hemisphere as is necessary to expose the fibers spreading out to the cortex of the middle lobe. Turn to the inferior surface and, **being careful to leave the flocculus in place and uninjured,** follow in a similar fashion the same group of fibers from this aspect. It will be evident that this peduncle is distributed to the middle lobe and, if you are interested, you can further demonstrate that the fibers, which are rostral in the pons are distributed caudally in the cerebellum, and the fibers which are caudal in the pons pass ventrally to reach the rostral parts of the middle lobe.

Now peel away fibers of the middle cerebellar peduncle (together with cortex) until only a thin plate of the middle lobe remains. You will come upon a gray nuclear mass, the **dentate nucleus,** in the interior of the hemisphere. Dissect this free of covering fibers when it will be evident that the fibers issuing from the nucleus constitute the **superior cerebellar peduncle.** By paring off thin slices with the knife you can demonstrate the crumpled appearance of this nucleus.

Re-identify the **pyramid** and **uvula** lying in the *vallecula.* Lateral to them observe a discrete little 'lobule' the **tonsil.** Using the handle of the knife, carefully scoop out and remove the tonsil without injuring the surrounding tissue. This will lay bare a delicate, transparent, semilunar membrane with a free edge, the **inferior medullary velum.** Lift the velum up carefully without tearing it and so demonstrate its continuity laterally with the **flocculus** and medially with the midline **nodule.** The flocculi, vela and nodule together constitute the **flocculo-nodular lobe,** and their contribution to the formation of the inferior part of the roof of the fourth ventricle can now be appreciated.

Fourth Ventricle

The tent-like roof of the fourth ventricle comes to an apex at the white center of the cerebellum. In front of this apex, the roof consists of the converging superior cerebellar peduncles with the superior medullary velum stretching between them. Behind this apex, while the roof is mainly an ependymal layer separating the cavity from the cerebello-medullary cistern, yet, in part, the inferior medullary velum, still in place, enters into its formation. The torn edges of the ependyma may perhaps be seen along the inferior boundary of the space where the medulla opens out. The pia mater covering the caudal part of the ependymal roof (i.e., the anterior wall of the cerebello-medullary cistern) reaches to the inferior medullary velum where it turns backwards to cover the inferior surface of the cerebellum. Thus a fold, the **tela choroidea of the fourth ventricle,** is produced similar in arrangement to the tela choroidea of the third ventricle. Between the layers of the fold the **choroid plexus of the fourth ventricle** invaginates the ependymal roof in a T-shaped manner. The three points of the T protrude through three openings in the roof. At the point where the inferior medullary velum becomes the flocculus, and on the lateral side of the inferior cerebellar peduncle where it makes its sharp turn backwards, look for one of these openings, the **lateral aperture of the fourth ventricle.** By turning the fila of NN. IX and X medially you will be enabled to see the choroidal plexus projecting through the opening. This opening, with its fellow of the opposite side, permits the escape of cerebro-spinal fluid from the ventricular cavities into the cerebello-medullary cistern. A third and midline opening, the **median aperture of the fourth ventricle,** exists in the ependymal roof of the caudal half of the cavity, through which the plexus also

projects, but it was destroyed with the ependymal roof, in the dissection of the cerebellum.

In order to expose the floor of the fourth ventricle, incise the superior medullary velum vertically in the midline and carry the incision through the remains of the vermis of the cerebellum. Turn the pieces to the right and left, and examine the floor of the cavity thus opened.

It is rhomboidal or lozenge-shaped and possesses four borders and four angles. The rostral half of the rhomboidal floor is, of course, triangular and is confined to the pons; the caudal half, also triangular, is confined to the medulla. Turn the specimen back and forth in order to verify these statements and to observe further that the medulla extends caudally beyond the limits of the cavity and is divisible, therefore, into two parts: (1) a rostral part or **open medulla** and (2) a caudal part or **closed medulla.**

The pontine half of the floor of the cavity is bounded laterally, where floor meets roof, by the converging superior cerebellar peduncles; the medullary half is bounded laterally, where floor meets roof, by a succession of structures. These are, from below upwards and from medial to lateral: (1) the **nucleus gracilis,** a slight swelling at the summit of the long **fasciculus gracilis** occupying the dorsal territory of the spinal cord immediately adjacent to the midline; (2) the **nucleus cuneatus,** a similar swelling, at the summit of a similar **fasciculus cuneatus,** occupying the dorsal territory of the spinal cord immediately lateral to the preceding; (3) the **inferior cerebellar peduncle.**

At the four angles are four openings; the rostral opening leads to the aqueduct of the mid-brain; the caudal opening leads to the central canal of the closed medulla; and the lateral openings in the **lateral recesses** have already been observed.

A median sulcus divides the floor of the fourth ventricle into two symmetrical halves. If the fibers of N. VIII be traced medially some of them will be observed to cross the floor and sink into the interior in the midline; these are the *auditory striae.* Lateral to the median sulcus, on each side, is a less obvious parallel sulcus, the **sulcus limitans**; it divides a motor area, medial to it, from a sensory area, lateral to it. The lateral area, both above and below the striae, is the **acoustic area,** deep to which lie the **vestibular nuclei.** The medial area of the pontine half of the floor presents a slight eminence, the **facial colliculus,** produced by fibers from the **facial nucleus** looping behind the **abducent nucleus.** Where the lower fibres of the auditory striae cross the sulcus limitans is a little pit or depression, the *inferior fovea;* from the fovea runs a shallow groove towards the apex of the medullary triangle. The groove separates a little triangle medial to it, the **hypoglossal trigone,** from a little triangle lateral to it, the **vagal trigone.**

Medulla

The medulla begins at the lower border of the pons and is considered to end just rostral to the exit of the fila or rootlets of the 1st cervical nerve. It is about $\frac{3}{4}''$ long and of wider caliber above than below. The rostral portion, forming the lower half of the floor of the fourth ventricle, has been identified as the **open medulla,** and the caudal portion surrounding a central canal, the **closed medulla.** The medulla is divided into symmetrical halves by an **anterior median fissure** and a **posterior median sulcus.** The former ends above in a pit, the *foramen caecum.* The dorsal aspect of the open medulla has been studied; that of the closed medulla consists of the two ascending fasciculi already identified. Just lateral to the nucleus cuneatus an indefinite swelling may be observed. It

is the **tuberculum cinereum** and is produced by part of the nucleus of N. V and the tract descending from it.

The lateral area of the medulla is occupied by a very prominent nuclear mass, the **olive.** In the groove dorsal to it were found the rootlets of NN. IX, X and XI; in the groove ventral to it, those of N. XII.

The ventral area lying on each side of the anterior median fissure is occupied by the prominent descending **cortico-spinal tract,** here known as the **pyramid.** Open the median fissure by gently separating the pyramids and observe the coarse bundles of their *decussation* in the lower part of the medulla. Along the transverse line intervening between the pons and the medulla may still be seen the points of exit of NN. VI, VII and VIII in that order from medial to lateral.

You may find it desirable to do no more dissection but to preserve the specimen in its present condition for review. However you will find it profitable, if you have time, to proceed a little further.

Internal Capsule and Corpus Striatum

Divide the remainder of the brain into two parts by a median section through the third ventricle; this permits you to examine more freely the medial wall of that cavity. Identify the anterior column of the fornix then (by scraping away the lateral wall of the third ventricle) follow it to its termination in the mammillary body. Take the left half (in which the lentiform nucleus is still intact) and, with a large wet brain-knife, cut a horizontal section at a level passing through the thalamus and through the head of the caudate nucleus. Observe that the **internal capsule** consists of: (a) the **anterior limb,** between the head of the caudate nucleus and the lentiform nucleus. Here the fibers

proceeding to and from the frontal cortex take an almost horizontal direction; (b) the **genu** (L. = knee) or bend; and (c) the **posterior limb,** in part between the thalamus and the lentiform nucleus and in part retro-lenticular. The fibers in the genu and those in the anterior part of the posterior limb run in a vertical direction and are therefore seen in cross section. The retro-lenticular fibers have already been observed proceeding horizontally from the thalamus to the occipital region, as the posterior thalamic radiation.

Note also in this section that the lentiform nucleus consists of two parts separated by a thin layer of white matter; the outer or lateral part, the **putamen,** is the larger and darker in color, whereas the inner or medial part, the **globus pallidus,** is smaller and paler in color. (It is possible on a good specimen to observe that the globus pallidus is similarly divided into two parts.) Medullated fibers pass between these various parts; thus the whole nuclear mass takes on a striated appearance and justifies its name, **corpus striatum.**

On the right half (in which the lentiform nucleus has been removed) turn to the medial surface of the specimen. The head of the caudate nucleus, as seen in the anterior horn of the lateral ventricle, appears large and globular. Incise the ependyma between the thalamus and the head of the caudate nucleus and remove the nucleus by inserting the handle of the knife deep to it and easing it away by a rocking movement of the handle. It will be noticed that the globular appearance was deceptive for the 'head' is now seen to be, in reality, not more than $\frac{1}{4}''$ thick. Verify this by inspecting the horizontal section. When the nucleus is removed the fibers of the anterior limb of the internal capsule are fully displayed; they have a well defined lower border around which the head of the caudate nucleus is continuous with the lentiform nucleus at the anterior perforated substance.

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